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WORKING PAPERS FOR SYMPOSIUM OF KORE
DEVELOPMENT INSTITUTE July 5-6, 197

概 觀 文 献

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研究調査報告
第 7 卷

開館記念심포지움

發表論文集

1972. 7

韓國開發研究院

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한국개발연구원은 우리나라 경제 건만에 관한 정책과제를 체계적으로 연구하여 국가의 5개년계획 수립 및 정책입안을 돕기 위한 연구기관으로서 1971년 3월 11일 박정희대통령에 의해 설립되었다.

이 연구원은 자체기금으로 운영되는 비정리법인이므로 그 정책지향적인 연구활동에 있어 자율성과 독립성이 최대한으로 보장되고 있다.

이 연구원의 모든 연구결과는 수시로 보고서로 발간되어 배포된다.

이 보고서에 발표되는 결론과 정책건의를 포함한 모든 내용은 이를 담당한 보고서작성자의 의견이며 결코 이 연구원의 공식의견이 아님을 밝혀 둔다.

開館記念 심포지움 發表論文 要約

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1. 租稅收入豫測模型

首席研究員　　朴　宗　淇

首席研究員　　金　定　淳

1) '72～'73年의 稅目別 租稅收入 推計

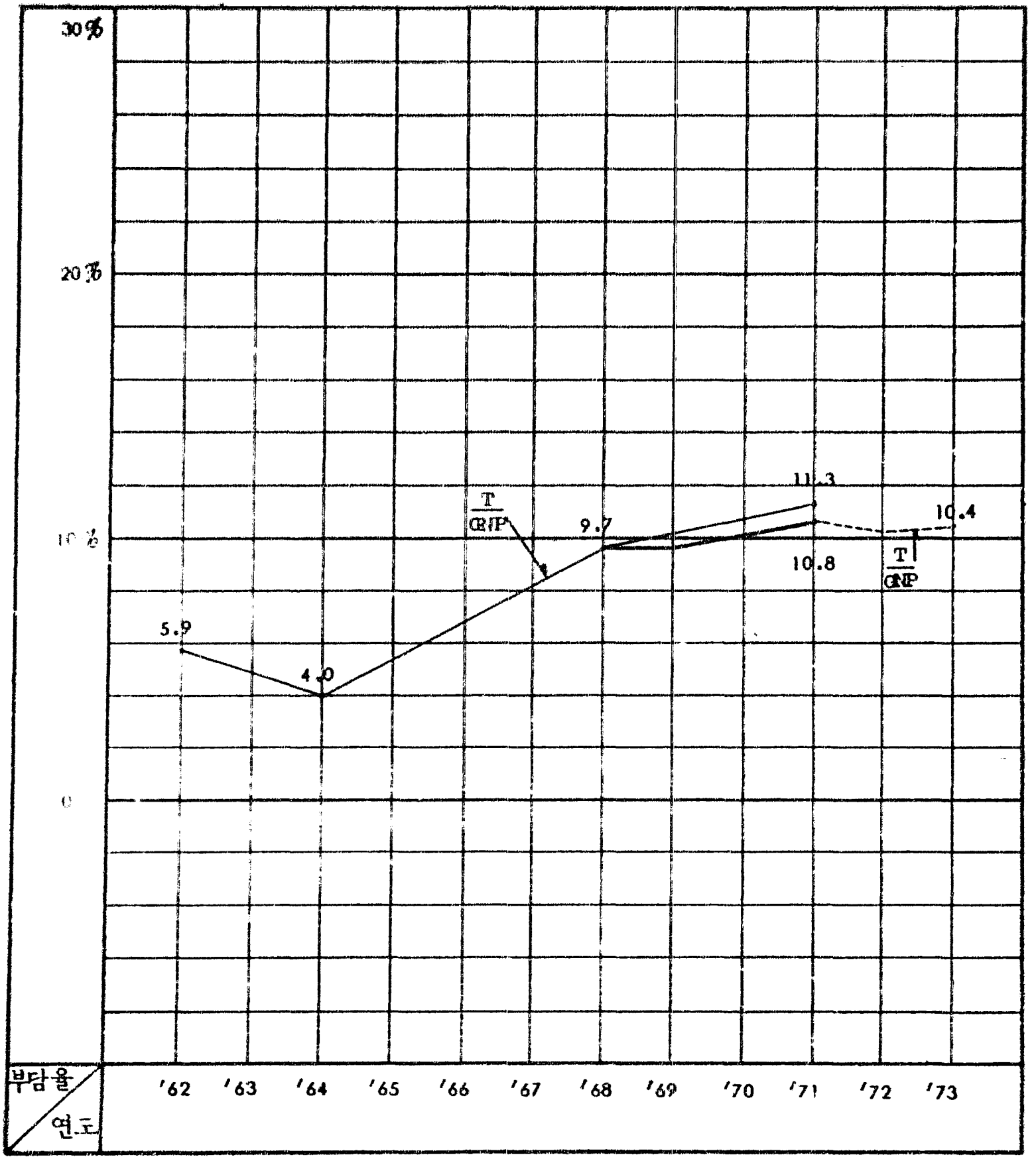
2) 所得, 個人消費支出등의 稅源과 稅率을 稅收의 說明變數로 取扱

3) 直接稅는 '65～'70年度(分期別)

間接稅는 '65～'71年度(上半期 下半期) 国稅庁의 資料를 使用

租 稅 負 担 率

(1962~1973)



租税推定値☆

（単位：10億円）

税目＼年度	'71 実績値	'72 豫算	'72 推定値	'73 推定値
所得税	106.7	99.0	104.7	127.1
法人税	48.3	63.0	47.5	60.1
登録税	8.4	22.3	12.4	15.6
相続税	2.1	1.4	2.4	3.0
資産再評価税	1.3	1.5	1.6	1.9
不動産投機抑制税	2.5	1.3	1.3	–
直接税計	169.3	188.5	169.9	207.7
営業税	36.5	46.0	51.6	61.5
物品税	34.4	56.3	42.3	50.8
織物類税	10.1	16.5	13.0	16.3
石油類税	30.5	40.0	39.4	50.1
酒税	26.4	43.0	33.1	39.5
入場税	4.7	8.7	6.7	7.9
通行税	16.4	13.8	20.6	24.9
電気ガス税	8.0	9.5	11.3	13.4
間接税計	167.0	233.8	218.0	264.4
総合計	336.3	422.3	387.9	472.1
（対前年度増加率）	（26.5%）	（25.6%）	（15.3%）	（21.7%）

☆ 操上徴収勘案

備考：'65～71年　平均増加率　43.4%

2. 經資源豫算을 위한

分期別 總量經濟豫測模型

首席研究員 宋 熙 秀

1) 분기별 총량경제 규모의 예측

2) 물가상승율의 동태적 분석과 도매물가 상승율의 예측

3) 분기별 국민소득 통계자료를 이용

4) 예측모형에 의한 1972~73년의 경제예측

<표 1>

산업별성장 및 물가동향예측('65년 불변가격)

단위 (금 액 : 10억원, 증가율, 구성비 : %)

연도		구분	국민 총생산	비농림 수산 부가가치	제조업 부가가치	사회간접자본 기타서비스 부가가치	고용 (백만명)	국제수지 적자 (백만불)	(1970=100.0) 전국도매물가지수 期末値	평균치
'72	상반기	금 액	686.08	599.14	236.18	362.96	4.9	457.91	122.33	121.10
		증가율	7.3	6.9	10.0	5.0	1.7	-11.5	6.2	15.3
	하반기	금 액	995.60	689.15	269.24	419.91	5.4	540.86	126.14	124.96
		증가율	7.4	9.4	13.6	6.8	4.2	13.1	3.3	11.1
	연 간	금 액	1,681.68	1,288.29	505.42	782.87	5.2	998.77	126.14	123.03
		증가율	7.3	8.2	11.9	6.0	3.0	0.3	9.5	13.3
		구성비	100.00	76.61	30.00	46.55	-	15.76	-	-
'73	상반기	금 액	749.41	658.99	270.43	388.56	5.03	411.61	130.51	129.22
		증가율	9.2	10.0	14.5	7.1	3.0	-10.1	3.5	6.7
	하반기	금 액	1,078.14	759.43	309.09	450.34	5.6	451.13	136.08	134.93
		증가율	8.3	10.2	14.8	7.2	3.0	-16.6	4.3	8.0
	연 간	금 액	1,827.55	1,418.42	579.46	838.96	5.3	862.74	136.08	132.07
		증가율	8.7	10.1	14.7	7.2	3.0	-13.6	7.9	7.4
		구성비	100.00	77.61	31.71	45.91	-	12.53	-	-

< 표 2 >

투자, 저축 및 국제수지동향예측 ('65년도 불변가격)

단위 〔금 액 : 10억원 / 증가율, 구성비 : %〕

연도		구분	국민 총생산	소비 지출	고정자본 형성	수입		수출		재고증가및 통계상의 불일치
						총수입	상품수입 (백만불)	총수출	상품수출 (백만불)	
'72	상반기	금액	686.08	690.53	197.32	344.86	1,054.44	223.33	644.39	-80.31
		증가율	7.3	8.8	2.0	3.6	0.7	14.3	25.6	-
	하반기	금액	995.60	761.09	259.57	417.87	1,265.43	274.33	790.73	118.48
		증가율	7.4	8.2	5.9	15.4	11.2	16.7	28.2	-
	연간	금액	1,681.68	1,451.61	456.89	762.73	2,319.87	497.66	1,435.12	38.18
		증가율	7.3	8.5	4.2	9.8	6.2	15.6	27.0	-
		구성비	100.00	86.57	27.98	45.36	36.01	29.55	22.62	2.27
'73	상반기	금액	749.41	745.37	224.72	379.50	1,147.66	270.26	815.41	-111.80
		증가율	9.2	7.9	13.9	10.0	8.8	21.0	26.5	-
	하반기	금액	1,078.14	818.47	281.49	451.72	1,367.93	331.99	1,001.62	93.49
		증가율	8.3	7.5	8.4	8.1	8.1	21.0	26.6	-
	연간	금액	1,827.55	1.563.84	506.21	831.22	2,515.59	602.25	1,817.03	-18.31
		증가율	8.7	7.7	10.8	9.0	8.5	21.0	26.6	-
		구성비	100.00	85.57	27.70	45.48	36.53	32.95	26.39	-1.00

5. 물가상승 요인분석

가. 물가방정식

$$\begin{pmatrix}\text{도매물가}\\\text{상 승 율}\end{pmatrix} = -0.74 - 0.17 \begin{pmatrix}\text{비농림부문}\\\text{생산증가율}\end{pmatrix}$$

$$+ 0.24 \begin{pmatrix}\text{통화량}\\\text{증가율}\end{pmatrix} + 0.36 \begin{pmatrix}\text{환 율}\\\text{상 승 율}\end{pmatrix}$$

$$+ 0.12 \begin{pmatrix}\text{미 가}\\\text{상 승 율}\end{pmatrix} + 0.20 \begin{pmatrix}\text{공공요금}\\\text{인 상 율}\end{pmatrix}$$

나. 요인별 물가상승 기여도

(1964 ~ 71)

<표 3>

물가상승기여도 (1964-71)

(단위: %)

요인 \ 기간		1964-71 (구성비)	1971 (구성비)
전국도매물가 연평균상승율(실제치)		11.0 (100.0)	13.0 (100.0)
비농림부문생산	연평균증가율	15.0	10.0
	상승기여도	-2.5 (-22.7)	-1.6 (-12.3)
통화량	연평균증가율	30.1	19.2
	상승기여도	7.2 (65.5)	4.5 (34.6)
환율	연평균증가율	14.0	17.7
	상승기여도	5.1 (46.4)	6.4 (49.2)
米價	연평균증가율	15.0	29.6
	상승기여도	1.8 (16.4)	3.6 (27.7)
공공요금	연평균인상율	15.0	9.1
	상승기여도	3.0 (27.3)	1.9 (14.6)
常數 CONSTANT	상승기여도	3.0 (-27.3)	-3.0 (-23.1)
도매물가 연평균상승율(예측치)		11.6 (105.4)	11.8 (90.8)

3. 総貨研究을 위한 総量模型

首席研究員　　金　宗　泰

1) '72 ~ '73年의 総量現模의 検討

2) '57 ~ '71年의 国民所得計定資料利用

総量規模의 豫算 ('65년 불변가격)

(單位 : 10億원)

구분 / Ω. 인 변	1972			1973	
	豫測値	總資源 豫算	增加率	豫測値	增加率
国民総生産	1,685	1,708	7.5	1,846	9.6
農林漁業	394	427	4.6	412	4.6
鉱工業	536	432	13.7	611	14.1
会社間接및 其他 SERVICE	778	849	8.4	855	9.9
消費	1,456	1,436	8.9	1,591	9.2
固定資本形成	462	495	5.3	469	1.6
輸出(百万$)	1,875	1,875	15.6	2,269	21.0
商品	1,435	1,435	27.0	1,817	22.6
輸入(百万$)	2,901	2,938	10.8	3,151	8.6
商品	2,347	2,298	7.4	2,535	8.0
海外貯蓄(百万$)	-1,026	-1,063	3.0	-882	-14.0

4. 製造業, 電氣, 交通部門에 있어서

生産要素의 寄与度 分析

首席研究員 李 奎 植

1) BRUNO 生産函数의 測定

2) 生産要素의 配分率 変動推移

3) 限界生産性, 労動과 資本의 代替弾力度 및 生産要素市場의 不均衡状態 測定

4) 生産要素의 成長寄与度 測定과 生産性의 変動推移

生産要素의 寄与度와 生産性 ('57~'70)

(単位 : %)

	製造業	電気	交通
生産増加率	14.68	18.29	14.98
労動増加率	8.75	4.08	7.74
資本増加率	5.65	18.83	7.04
労動配分率	35.15	13.79	2.31
資本配分率	64.85	86.21	97.69
労動寄与度	3.08	0.56	0.18
資本寄与度	3.69	16.23	6.88
生産性寄与度	7.30	0.60	7.64
(生産増加率에 対한)			
労動寄与度	20.95	3.08	1.19
資本寄与度	25.14	88.76	45.91
生産性寄与度	49.73	3.28	51.00

5. 우리나라 輸出産業의 生産性 分析

首席研究員 金 逸 敎

1. 対 象

가. 期 間

1966 ~ 1970

나. 対 象

204個 製造業産業

('66年度 鉱工業 CENSUS 基準)

2. 要 約

가. 輸出은 分析期間中 年平均 36.7%가 增加하였으나 生産性 (單純總所要 生産性)은 年平均 8.9%만이 增加함으로써 그 寄与率은 24.2%임.

나. 加重 總要素 生産性의 增加率은 單純總要素生産性 보다도 훨씬 낮은 5.4%만을 示顯하고 있는데 이는 輸出産業의 生産性 增加의 相当한 部分이 構造変動에 基因하고 있음을 指摘하는 것임.

다. 輸出의 增加는 生産性의 增加보다는 産出量의 增加와 相關關係가 높음.

라. 労動集約인 産業이 資本集約인 産業보다 生産性이 높음.

마. 輸出産業의 生産性이 輸入代替 및 內需産業의 生産보다 낮은데, 이는 技術의 落後, 規模経済의 欠如等에 基因함.

바. 輸出産業의 資本装備率이 輸入代替 및 內需産業보다 훨씬 낮은데도 不拘하고 資本係数는 거의 같은데, 이는 輸出産業의 低生産性에 基因함.

사. 相当한 数의 輸出産業에 있어서 実質賃金의 上昇이 労動生産性의 增加를 앞지르고 있음.

(食料品, 繊維, 土石製品, 第一次金属, 金属, 機械, 電気機械 및 器具)

5. 輸出産業 中 分類別 資本装備率 및 生産性增加率

(1966~1970)

産業区分	資本装備率 (%)	総所要生産性 (単純) (%)	労動生産性 (%)	資本生産性 (%)
食料品	7.0	10.7	13.4	10.4
繊維	5.9	12.1	15.9	10.1
靴類衣服類및장신품	-2.0	6.0	3.0	8.7
製材業 및 木製品	41.7	-6.1	10.1	-11.2
皮革 및 皮革製品	6.5	30.5	7.3	44.6
고무製品	24.0	10.3	25.1	2.8
土石 및 유리製品	17.8	2.3	3.1	6.7
第1次金屬	84.8	7.1	18.9	8.8
金屬製品	8.3	5.6	9.0	4.5
機械	30.1	-11.5	6.6	-19.7
電気機械器具	-1.5	31.5	31.0	33.9
其他	17.4	14.2	12.6	24.1
輸出産業計	7.5	8.9	13.8	6.4

4. 輸出産業, 輸入代替産業 및 內需産業의 中分類別 總要素生産性 增加率

(1966~1970)

産業区分	輸出産業		輸入代替産業		內需産業	
	単純生産性	加重生産性	単純生産性	加重生産性	単純生産性	加重生産性
	%	%	%	%	%	%
食料品	9.0	20.0	34.5	34.5	19.4	15.6
飲料品	-	-	-	-	9.0	9.1
煙草	-	-	-	-	58.7	58.7
纖維	12.1	9.9	-	-	7.2	7.5
靴類衣服類및장신품	6.0	6.2	-	-	-	-
製材業 및 木製品	-6.1	-8.7	-	-	1.7	1.6
器具 및 装置品	-	-	-	-	7.7	7.7
紙類 및 紙類製品	-	-	-	-	7.9	6.6
印刷·出版	-	-	-	-	9.4	9.3
皮革 및 皮革製品	30.5	30.5	-	-	15.4	10.5
고무製品	10.3	10.3	-	-	19.0	18.1
化学製品	-	-	29.6	26.3	25.6	20.1
石油 및 石炭製品	-	-	-	-	12.1	17.0
土石 및 유리製品	2.3	0.0	2.4	2.0	9.8	9.7
第一次金属	7.1	7.1	7.4	3.7	-1.4	0.7
金属製品	5.6	4.7	27.6	27.6	18.1	18.5
機械	-11.5	-11.6	8.3	8.7	-	-
電気機械器具	31.6	30.3	23.5	19.9	17.4	6.0
輸送用機械器具	-	-	17.4	4.4	15.0	15.4
其他	14.2	9.5	25.6	25.6	12.5	12.3
製造業計	8.9	5.4	21.4	8.5	14.2	14.0

6. 우리나라 製造業의

企業集中度와 市場成果

首席研究員 南 祐 鉉

1. 目 的: 集中度에 의한 産業構造의 分析과 独寡占 規制 立案에 指針 提供

2. 資 料: '66~'69年度 鉱工業 CENSUS 및 調査報告書와 企業経営分析

3. 結 果:

a. '66~'69年度 集中度 指数는 3%의 小幅的 그러나 持続的 增加趨勢

企業集中度 指数

	1935	1947	1966	1969
韓国			49.8%	53.2%
美国	44.0%	41.4%		

企業集中度 指数

(66年 生産構造基準)

年度	1966	1967	1968	1969
集中度	49.8	49.6	48.1	48.5

b. 企業集中 決定要因中 規模의 経済, 広告費가 強하게 作用. 需要의 増大는 그를 鈍化시킨 要因이 되었다.

産業別로는 一般産業에 比하여 下記와 같이 集中度가 높게 나타남.

- o 輸入代替産業 18 - 21 %
- o 輸出産業 12 %
- o 輸入原料依存産業 8 %

c. 企業集中産業의 市場活動分析

集 中 度	70 % 以上	70 % 以下
総資本利潤率 (68-69)	5.77	3.84
施設利用度 (67-69)	69.46	71.32

7. 1972年末 適正換率의 算定

首席研究員 具 本 湖

1) 현행 지원제도의 계속

o 10% 도매물가 상승예상 : 398.28 원

o 14% 도매물가 상승예상 : 409.85 원

2) 현행 수출지원비를 전제

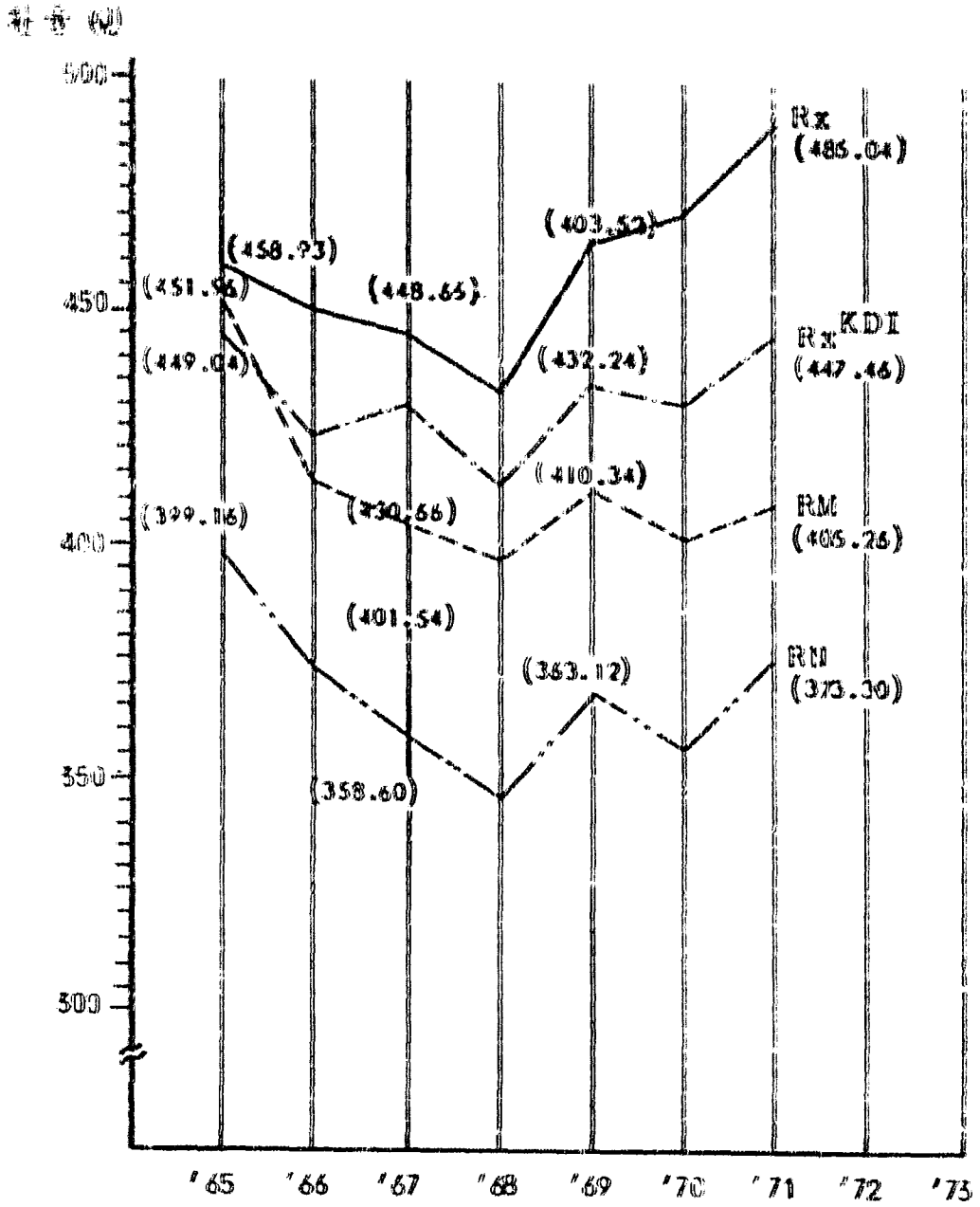
o 수출증가율 27% : 실효환율 467.24 원

o 수출증가율 33% : 실효환율 477.80 원

諸換率의 推移 (年末基準)

		'65	'67	'69	'71
엔 화 집 중 환 율		271.78	274.60	304.45	373.30
구 매 력 평 가 지 수		100	88.74	81.29	67.69
실질환율 (65 년기준)		271.78	243.68	247.49	252.69
구 매 력 평 가 환 율		(271.78)	(306.27)	(334.33)	(401.51)
실질실효환율 ('71 기준)	수출 (새래방식)	458.95	448.66	463.52	485.04
	수출 (KDI 방식)	449.04	430.66	432.24	447.46
	수입	451.96	401.54	410.34	405.26

제 실질환율 추이



주 :

RN : 구매력실질환율 (1971 년기준)

Rx : 수출실질실효환율 (새래방식 1971 년기준)

Rx^{KDI} : 수출실질실효환율 (KDI 방식 1971 년기준)

RM : 수입실질실효환율 (1971 년기준)

8. 越南戰爭과 韓·日国交正常化가 1960年代 우리나라 經濟成長에 미친 影響

首席研究員 朱 鶴 中

分析結果

1. 所得効果

(1965 不変価格 単位: 10億원)

項目 \ 年度	1965	1966	1967	1968	1969	1970
対日輸出	9.7	13.3	17.0	19.4	24.1	40.3
対越輸出 및 軍納	2.1	4.0	4.0	7.6	8.1	10.9
特許, 技術者送金	-	4.9	14.8	15.3	15.8	11.6
合計	11.7	22.3	35.9	42.2	48.1	62.8
(GNP 대비율)	(1.45)	(2.44)	(3.61)	(3.74)	(3.68)	(4.42)

2. 雇傭効果

（単位：1,000 人／年）

項目＼年度	1965	1966	1967	1968	1969	1970
対日輸出	70.7	98.3	117.5	139.4	170.4	283.0
対越輸出 実軍納	9.0	20.7	22.8	51.7	56.3	67.1
将兵・技術者送金	-	46.4	139.8	136.4	141.2	103.5
合計	79.7	165.4	280.1	327.5	367.9	453.6
年増加 (A)	-	85.7	115.7	37.4	40.4	195.7
総雇傭	8,522	8,695	8,914	9,261	9,347	9,[illegible]
年増加 (B)	-	137	255	347	86	227
A／B	-	62.6%	45.4%	10.8%	47.0%	86.2%

(1965년 불변가격
단위 : 10억 원)

연 도	기계수송기구수입액 (1)	기계수송기구수입액중청구권분 (2)	고정자본형성중기계수송기구 (3)	총고정자본형성액 (4)	(1)/(3) (5)	(2)/(3) (6)	(1)/(4) (7)
					%	%	%
1965	6.81	-	38.02	117.64	17.91	-	5.79
1966	20.40	0.95	88.38	190.63	23.08	1.07	10.70
1967	33.83	4.18	114.90	232.09	29.44	3.64	14.58
1968	55.97	3.44	157.93	325.63	35.44	2.18	17.19
1969	65.55	4.62	184.22	407.76	35.58	2.51	16.08
1970	61.94	3.47	175.07	416.76	35.38	1.98	14.86
1971p	65.11	3.46	207.50p	438.54p	31.38	1.67	14.85

p : 잠정추계

(단위 : 100만불)

		'64		'67			'70		
		일 본	전세계	일 본	월 남	전세계	일 본	월 남	전세계
무역	수 출	38.2	119.1	84.7	5.7	334.7	245.2	13.4	882.2
	수 입	-104.5	-364.9	-420.5	-0.1	-908.9	-736.3	-0.2	-1,804.2
	비화폐용금	-	0.9	-	-	-	-		-
	무역수지	-66.3	-244.9	-335.8	5.7	-574.2	-491.1	13.2	-922.0
용역 및 이전	수 입	19.2	147.7	22.7	127.8	410.1	65.3	138.4	615.4
	지 출	-7.0	-70.8	-43.3	-	-164.3	-118.7	-	-432.5
	용역 및 이전순계	12.2	76.9	-20.6	127.8	245.8	-53.4	138.4	212.9
계	경상거래 순 계	-54.1	168.0	-356.4	138.4	-328.4	-544.5	151.6	-709.1
	(전세계 비율)	(32.2)		(108.5)	(40.6)		(76.8)	(21.4)	

결 론

1. 소득효과 기간중 GNP의 1.5% - 4.4%

2. 고용효과 기간중 고용증가의 10.8% - 86.2%

3. 대 일본 수입품의 총고정자본형성기여율

기간중 6% - 17%

특히 직접적 생산고정자본(기계, 수송기구) 비율은

18% - 36%

4. 가) 한·일국교정상화는 국제수지 경상거래의 악화를 초래

(기간중 총경상적자가 76.0% - 108.5%)

나) 월남파병은 특히 용역거래에서 일어난 수입은 국제수지개선에

기여(기간중 총경상적자의 21.4% - 40.6%의 흑자)

開館記念　심포지움　発表論文

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KOREA'S FOREIGN EXCHANGE POLICIES: AN EVALUATION AND PROPOSALS

Bonho Koo

Working Paper 7207

Korea Development Institute

May 1972

PREFACE

This paper is one in the series of continuing KDI research works which is designed to aid in the formulation of sound public policies and to promote public understanding of issues of the Korean Economy.

This paper is a part of our on-going research in the pursuit of estimating Korea's shadow exchange rate. It starts from a survey of Korea's foreign exchange system, followed by a critical evaluation of Korea's present foreign exchange system. Ultimately it aims to estimate Korea's optimum exchange rate. It is hoped that this paper will help to stimulate the exchange of useful knowledge for the future improvement.

The interpretations and conclusions in this paper are those of the author or authors and do not represent the views of the Korea Development Institute. Finally, I would like to extend our appreciation to those within and outside of this Institute who have participated in these endeavours.

Mahn Je Kim
President

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I. INTRODUCTION

The foreign trade of Korea as in many other underdeveloped economies has been particularly vulnerable to a variety of restrictions and subsidies on both imports and exports. Modern trade theory tells us that unified exchange rates are theoretically suboptimal in the presence of factor market imperfections, externalities, monopoly, and "infant stage". In practice, however, the administrators in government may lack the ability to correctly estimate the magnitudes of "imperfections" or externalities".

Since 1965 the Korean government has nominally adopted a unified floating exchange rate but effectively practiced a multiple exchange rate system. Many of the adverse effects resulting from Korea's de facto multiple exchange rate system will be indicated and explained. Then we will propose that a realistic adjustment of the exchange rate should proceed the resort to other measures to stimulate exports and to restrict imports. In the final chapter, various approaches will be taken to estimate a proper level of Korea's foreign exchange rate. In contrast with the gap theory and other pessimistic views on the potency of exchange rates in restoring both internal balance and external balance, the characteristic of this paper is to show that an adjustment of exchange rates can serve as a powerful policy measur in restoring both internal and external balance even in developing economies.

II. A SURVEY OF KOREA'S FOREIGN EXCHANGE SYSTEM

1. Korea's Nominal Exchange Rates

Following the foreign exchange crisis of 1963-1964 an exchange rate reform was announced in early May 1964, when the official rate was raised from 130 won to 255 won per U.S. dollar. The reform also involved transformation of the multiple, fixed-rate system to a fluctuating, unitary rate for all transactions. The actual implementation of the unitary fluctuating exchange rate was, however, announced later on March 22, 1965. Under this "floating" system the Bank of Korea posted daily buying and selling rates with an eye to the free market. Immediately after the announcement of the new floating system, the first market exchange rate was formed at W270 to a dollar. The exchage rate, however, declined gradually to W256 to the dollar at the end of April 1965. The rate began to rise in May and the market exchange rate was quoted at W280 per dollar by the end of May. On June 22, 1965, the Bank of Korea started to intervene in the market by increasing the supply of exchange certificates, but in the beginning the BOK intervention was limited and allowed the market exchange rate fluctuate to a certain extent. From August 22, 1965 through 1967, the exchange rate was, however, completely pegged at around W272 to the dollar by the BOK, while Korea's wholesale price index increased from 100 to 115.8 between 1965 and 1967. Although from 1968 to 1970 the exchange rate was allowed to depreciate, the degree of depreciation was limited by intervention

from the BOK. In June 1971, the won was devalued by about 13 percent from 326.4 to 370.8 won to the dollar. After the June devaluation, the exchange rate was again pegged by BOK intervention in the foreign exchange market until early December 1971. After December 3, 1971, the exchange rate was allowed to devalue in the foreign exchange market, reaching W373.3 per dollar at the end of 1971 and W392.90 per dollar on April 30,1972. (See Table 1)

2. Korea's Purchasing-Power-Parity Exchange Rate

The purchasing power parity theory has been developed almost exclusively with respect to changes on the monetary side in the form of differential rates of inflation between countries. Hence the purchasing power parity theory has the obvious limitation of partial equilibrium analysis. Neither changes on the real side in the form of unequal rates of technical change, output, and productivity, nor capital movements are accounted for in measuring the purchasing power parity. The purchasing power parity theory has, however, survived as an approximate way for measuring international competitiveness, especially in the short run.

Table 1 below shows Korea's purchasing power parity exchange rates in relation to Korea's major trading countries between 1965 and 1971. Korea's purchasing-power-parity rate showed a continuous decline between 1965 and 1968 and a slight increase in both 1969 and 1970. Although Korea's purchasing-power-parity rate increased sharply in 1971, the rate still lagged below the 1965 level.

3. "Adjusted" Parity Exchange Rates

One conceptual difficulty with the purchasing power parity is that prices of many items which cannot enter foreign trade are included. Hence, it fails as an indicator of price movements in traded goods. In other words, wholesale price indices are weighted so heavily with standard goods of domestic consumption that it cannot be truly representative of any country's traded sectors. To moderate such biases, we have adjusted the parity rates using the import and export price indices in place of the wholesale price indices of Korea's major trading countries. These adjusted rates are also illustrated in Table 1. The trend of Korea's "adjusted" parity rates, although there are mild differences, shows the similarity to the trend of Korea's purchasing power parity, and the adjusted parity rate of 1971 also lagged below the 1965 level.

4. Korea's Effective Exchange Rates

Korea adopted various policy measures to promote exports and to restrict imports. In addition to the consideration of foreign exchange rates and relative price stability, the various policy measures should be therefore accounted for measuring the effective exchange rates.

The concept of effective exchange rates can be easily defined as follows: R_m stands for the effective exchange rate for imports, R_x the effective exchange rate for exports, N the official (nominal) exchange rate, t_m and t_x the ad valorem rates of tariffs and other taxes

and/or subsidies on imports and exports respectively. We then have the following relationships: $R_m = N(1+t_m)$, $R_x = N(1+t_x)$. However, the actual computation of effective exchange rates is subject to severe constraints. Firstly, some of the export-measures and import-restriction measures are hard to quantify. Government persuasion or pressure to expand exports, government-sponsored market research and other export promotion activities, encouragement of direct foreign investment, and import quotas are a few examples. These are omitted in our computation of effective exchange rates. Secondly, different commodities are subject to different rates of export subsidy or import duty. Various tax provisions and credit incentives in Korea imply different rates of benefit and/or cost for different commodities.

Two methods are used in our computation of effective exchange rates. The first method is to compute an average effective exchange rate based on aggregate data for the selected period. In the other method we select some major exports and compute different effective exchange rates for different commodities during the selected years.

(a) Average Effective Exchange Rates

When the value of aggregate international trade is recorded in terms of foreign currency, and the aggregate value of various export subsidies and import duties is recorded in terms of local currency, an aggregate effective exchange rate can be easily computed. In Table 1, nominal and various real effective exchange rates are illustrated.

(b) Different Effective Exchange Rates for Different Commodities

(i) Different effective exchange rates of exports

Various incentive measures to promote export activities effect-

ively resulted in differential subsidies and thus de facto multiple exchange rates. Differential export subsidies were intensified partly as a result of the proliferation of various forms of subsidies which were established to offset the adverse effect on exports of the overvaluation of Korea's exchange rate resulting from inflation. The government subsidy to earning one dollar through exports (by means of tax remissions or rebates, preferential loans and other subsidies) varied widely among the major commodities. It ranged from an effective subsidy of 125 won per dollar of export of nylon fabrics to 5 won per dollar of exports of fresh fish in 1969. (See Appendix 1)

(ii) Different effective rates of protection for different commodities

Although the tariff reform of 1967 slightly reduced the differentials of legal tariff rates, the rate structure remained widely varied from 13.5 per cent of mining and energy to 106.2 per cent of tobacco and beverages. In addition, various policy measures to promote export expansion and import substitution made effective rates of protection vary widely among different commodities. (See Appendix 2)

Table 1. Korea's Foreign Exchange Rates

(the year-end base)

	1965	1966	1967	1968	1969	1970	1971
1. Nominal Exchange Rates	271.78	271.18	274.60	281.50	304.45	316.65	373.30
2. Purchasing Power Parity Rates (1965 base)1/	271.78	254.50	243.68	235.47	247.49	238.88	252.69
3. Adjusted Parity Rates (1965 base)							
(a) Exports2/	270.96	250.14	243.02	236.71	249.55	243.21	258.33
(b) Imports3/	272.60	256.01	239.33	237.75	249.71	239.99	252.82
4. Real Effective Exch. Rates (1965 base)							
(c) Exports2/	318.24	301.70	311.57	308.84	321.44	324.18	336.38
(d) Imports2/	305.42	284.46	271.35	265.24	277.31	266.12	273.87
2A. Purchasing Power Parity Rates (1971 base)	399.16	373.17	358.60	345.03	363.12	354.55	373.30
3A. Adjusted Parity Rates (1971 base)							
(a') Exports	390.75	360.74	350.46	341.37	358.85	350.52	372.50
(b') Imports	403.39	378.87	354.12	351.84	369.51	355.14	374.10
4A. Real Effective Exch. Rates (1971 base)							
(c') Exports	458.93	435.10	449.30	445.38	463.52	467.22	485.04
(d') Imports	451.96	420.98	401.54	392.51	410.34	393.82	405.26

Sources; Bank of Korea, Ministry of Finance, and Economic Planning Board

Notes; 1/ Ratio of weighted wholesale price index of major trading partenrs to Korea's WPI is multiplied by Korea's nominal exchange rates:

1965	1966	1967	1968	1969	1970	1971
100	93.85	88.74	83.65	81.29	75.44	67.69

2/ Instead of using WPI of major trading partners, weighted unit value of major trader's imports is used.

3/ Conversely weighted unit value of major trader's exports is used.

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f. Adjusted parity index on exports							
(1965 base)	100	92.52	88.63	84.21	82.17	76.99	69.35
(1971 base)	144.21	133.43	127.81	121.44	118.49	110.96	100
g. Real effective exch. rate on exports (3 x f, 1965 base)	318.24	301.70	311.13	308.84	321.44	324.18	336.38
h. Real effective exch. rate on exports (3 x f, 1971 base)	458.93	435.10	448.66	445.38	463.52	467.22	485.04

5/ Real effective exchange rates of imports are computed in the following way.

1. Nominal selling rate	272.60	272.00	275.00	281.90	305.20	317.40	374.10
2. Effective cost per dollar import(a+b)	32.82	30.23	30.61	32.59	33.73	34.57	31.16
a. Effective tariff per dollar import	27.72	25.13	25.51	25.89	24.53	25.67	22.16
b. Interest cost of predeposit per dollar import	5.1	5.1	5.1	6.7	9.2	8.9	9.0

Table 1 (Continued)

	1965	1966	1967	1968	1969	1970	1971
3. Nominal effective exch. rate of imports (1+2)	305.42	302.23	305.61	314.49	338.93	351.97	405.26
4. Real effective exch. rate on imports							
c. Adjusted parity index on imports							
(1965 base)	100.00	94.12	88.79	84.34	81.82	75.61	67.58
(1971 base)	147.98	139.29	131.39	124.81	121.07	111.89	100.00
d. Real effective exch. rate on imports (3 x c, 1965 base)	305.42	384.46	271.35	265.24	277.31	266.12	273.87
e. Real effective exch. rate on imports (3 x c, 1971 base)	251.96	420.98	401.54	392.51	410.34	393.82	405.26

5. Some Modifications

The method used in computing Korea's average effective exchange rates in the Table 1 is basically similar to works of the Bank of Korea and Professor Balassa. In our opinion, however, two important points are not allowed in this computation. Firstly, the Big Ten agreement on new exchange rates on December 17, 1971, is not accounted at all. Secondly, tariff exemptions as an export subsidy in the above computation of effective exchange rates are quite exaggerated. These viewpoints will be now explained and the above computation of effective exchange rates will be accordingly modified.

(a) An estimated impact of the Big Ten Agreement on the value of Korean won

When the Big Ten countries agreed on new exchange rates on December 17, 1971, the U.S. dollar was relatively devalued as shown in Table 2-A. Since the exchange rate of Korean won is fixed in terms of the U.S. dollar, the Big Ten Agreement meant the effective devaluation of the Korean won. However, the impact of the new agreement on the Korean won must be independently computed because the composition of Korea's trading countries is different from that of the U.S. The implicit devaluation of the Korean won which resulted from the Big Ten Agreement is computed in Table 2-B and 2-C below. That is, Korea's exchange rates of imports and exports and its average rate were respectively devalued by about 7.83 per cent, 5.02 per cent and 6.96 per cent, or by 29.33 won, 18.74 won and 25.98 won.

(b) Is tariff exemption for imported inputs for exports an export subsidy?

Table 2-A New Exchange Rates Agreed by Big Ten Countries(Dec. 17, 1971)

Countries	Relative appreciation to the U.S. dollars(%)	Countries	Relative appreciation to the U.S. dollar (%)
U.S.A.	-	Netherland	+ 11.57
Swiss	+ 6.35	France	+ 8.57
Germany	+ 13.75	U.K.	+ 8.57
Japan	+ 16.88	Sweden	+ 7.49
Belgium	+ 11.57	Italy	+ 7.49

Table 2-B An Estimated Impact of the Big Ten Agreement on Effective Exchange Rates of Korea's Imports.

Countries	1971 Korea's Imports		Induced nominal devaluation of Korean won resulted by the Big Ten Agreement(%) (2)	Devaluation of Korea's average effective exchange rates resulted by the Big Ten Agreement (3) = (1) x (2) (%)
	Total imports (1,000$)	Share of imports(%) (1)		
Japan	953,778	39.84	16.88	6.73
EEC including U.K. and Sweden	257,743	10.74	10.25	1.10
U.S.A. and other countries	1,182,799	49.42	0	0
Total	2,394,320	100.00		7.83

Won devaluation on imports 0.0783 x 373.30 = 29.23 (won)

Table 2-C An Estimated Impact of the Big Ten Agreement on Effective Exchange Rates of Korea's Exports.

Countries	1971 Korea's Exports: Total exports (1,000$)	1971 Korea's Exports: Share of exports(%) (1)	Induced nominal devaluation of Korean won resulted by the Big Ten Agreement(%) (2)	Devaluation of Korea's average effective exchange rates resulted by the Big Ten Agreement (3) = (1) x (2) (%)
Japan	261,988	24.54	16.88	4.14
EEC including U.K. and sweden	82,506	7.73	11.35	0.88
U.S.A. and other countries	723,113	67.73	0	0
Total	1,067,607	100.00		5.02

Won devaluation on exports 0.0502 x 373.30 = 18.74 (won)

Average won Devaluation : 1,067,607/3,461,927 x 5.02 + 2,394,320/3,461,927 x 7.83 = 6.96(%)

0.0696 x 373.30 = 25.98 (won)

In the above Table 1, tariff exemptions for imported inputs for exports are accounted as export subsidies. In the 1971 example of Table 1, the 50.89 won tariff exemption per dollar export is computed in the following way:

$$\sum_{i=1}^{n} M_i \times t_i \; / \; \text{value of 1971 exports}$$

where M_i and t_i respectively stand for cif value of imports for export production in terms of Korean currency and the ad valorem nominal rate of tariff. In the Table 1, the weighted average rate of nominal tarif for imported inputs for exports amounted to about 38 per cent. It is true that such tariff exemptions are export-subsidies if these imports and/or their products from using these imports were allowed to sell in the domestic market. But, the tariffs are exempted on the basis that the imports are used for the production of exports. On this matter, we cannot expect perfect honesty from producer-cum-exporter. Technically and in practice, the producer-cum-exporter manages to leak some of their products for domestic sale instead of for exports. This must be, however, separately imputed as an export-subsidy in the category of "leakage to domestic markets." If we assume the perfect honesty of the producer-cum-exporter, these tariff exemptions are not export subsidies from the viewpoint of the producer-cum-exporter who has to sell at world market prices. In other words, the producer-cum-exporter who had to pay the tariff for imported inputs for the production of exports is effectively getting negative protection if competitors of Korean exporters at the world market do not pay tariffs or taxes for such inputs. This view is adopted

in computing the "modified" effective exchange rates of exports in Table 3 below. Two alternative assumptions are used. In one case we assume that competitors of Korean producer-cum-exporters in the world market do not pay tariffs or taxes for equivalent inputs and that Korean producer-cum-exporters do not leak their imported inputs and/or their products for domestic sale in an illegal way. This assumption is used in computing row 3 of Table 3. Alternatively, we assume that competitors of Korean producer-cum-exporters in the world market pay certain ad valorem tariffs or taxes for equivalent inputs, and that Korean producer-cum-exporters leak a certain portion of their imported inputs and their products for domestic sale. On the basis of this latter assumption, tariff exemptions for imported inputs for exports are effectively partial export subsidies. In row 5 of Table 3, the amount of these effective subsidies are crudely assumed to be about 10 per cent of cif value of imported inputs for exports. In short, Korea's effective exchange rate of exports at the end of 1971 would be around 447.46 instead of about 485.04 on the basis of the latter assumption.

Table 3. Modified Effective Exchange Rates of Exports

	1965	1966	1967	1968	1969	1970	1971
1. Nominal Effective Exch. Rate of Export	318.24	326.09	351.04	366.75	391.19	421.07	485.04
2. Tariff Exemptions per Dollar Export	15.37	18.21	22.58	36.24	36.23	42.64	50.89
3. "Ideally Modified" Nominal Effective Exchange Rates by Assuming Tariff Exemptions Not As Export Subsidies (1-2)	302.87	307.88	328.46	330.51	354.96	378.43	434.15
4. Imputed Export Subsidies per Dollar Export by the Alternative Assumption	8.51	8.64	8.49	9.12	9.83	10.57	13.31

Table 3. (Continued)

	1965	1966	1967	1968	1969	1970	1971
5. "Crudely Modified" Nominal Effective Exchange Rates by the Alternative Assumption (3+4)	311.38	316.52	336.95	339.63	364.79	389.00	447.46

6. Summary and Characteristics of the Present System

From the above survey, we can sum up the following characteristics.

(1) Although the Korean won was devalued several times after 1965, Korea's parity exchange rates continuously lagged below the level of 1965, in spite of some increase in 1969 and 1971. (See Table 1)

(2) To offset the adverse effect on exports of the overvaluation of Korea's exchange rates resulting from inflation, various export-promotion measures were adopted. As a result the real effective exchange rates on exports had not been lagged much below the parity rate of 1965 and in fact became even more favorable for exports after 1969.

(3) On the other hand, the real effective exchange rates on imports had been generally decreasing although some reversing trend was indicated after 1969.

(4) As a result real effective exchange rates diverged between exports and imports. In addition, effective exchange rates varied widely for different commodities. Thus, de facto multiple exchange rates were in practice.

III. AN EVALUATION OF THE PRESENT SYSTEM

Korea's export expansion and impressive economic growth could not have been achieved without adopting export-oriented policies. But these export-oriented policies, coupled with Korean inflation, have brought about a *de facto* multiple exchange rate system and the nominal overvaluation of the Korean won.

1. Adverse Effects Resulting from the Present System

Modern trade theory contends that unified exchange rates are suboptimal in the presence of factor market imperfections, externalities, monopoly, and "infant export industries." Under these circumstances a tax-cum-subsidy and/or a tariff-cum-subsidy are theoretically optimal. However, in practice, the efficient administration of these measures is not easy. A tax-cum-subsidy and/or a tariff-cum-subsidy interventions require an ability to estimate correctly the magnitudes of the "imperfections" or "externalities." In view of the uncertainties regarding the parameters of the systems which are candidates for adjustment, together with a lack of expertise among the administrators making the adjustments, and the temptations to subject the adjustments to political manipulation, it may well be that distortions and imperfections are likely to be accentuated rather than offset by public intervention. Korea's *de facto* multiple exchange rates with the nominal overvaluation contributed many adverse effects. Although relatively high effective exchange rates on exports through various export subsidy measures contributed

to the continuous expansion of Korea's exports, tariff exemptions for the import of raw materials of exports with a nominal overvaluation made effective exchange rates on imported inputs asymmetrically low. This asymmetrical cheapening of imported inputs is defended in order to channel needed imports of capital goods and raw materials for export expansion and industrialization. This has, however, misallocated resources in the following ways. Firstly, the cheapening of imported inputs penalizes domestic producers (existing and potential) of capital goods and raw materials with respect to foreign competitors. It discourages the development of domestic resources and of new skills at earlier stages of the production of exports. Thus it discourages the development of backward linkages and provides additional bias against the learning process (and it may even contribute to the inferiority complex of domestic producers). Secondly, a mix of low exchange rates on imported inputs and high exchange rates on export may encourage "finishing-touch" type industries which use a large proportion of imported inputs. Average rates of net foreign exchange earnings in Korea's exports had been decreased from 70.1 per cent in 1966 to 56.7 per cent in 1970.[1] Thirdly, the cheapening of imported capital goods may accelerate overinvestment and contribute to the excess capacity. Korea's level of capital utiliza-

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[1] The Professorial Evaluation Team, /19/

tion rates in the 1960's was lower than that in advanced countries, according to the recent studies of Professors Kim and Kwon.[2] In addition the present system of de facto multiple exchange rates creates complicated procedural work and red tape which mean greater implicit costs and administrative time lag from the viewpoint of an exporter. Farther it may invite governmental corruption and collusion between businessmen and governmental officials. Once adopted it is hard to terminate this "comfortable" collusion. In extreme cases it can lead to situations where more foreign exchange is devoted to purchasing imported inputs than is earned from the sale of the exported product.

In short, a tax-cum-subsidy or a tariff-cum-subsidy should not be substitutes for a devaluation of the exchange [illegible]. As a first step, exchange rate devaluation should precede the resort to other measures to stimulate exports and to restrict imports. Devaluation has the advantage of being efficient with respect to the relative stimulus which it gives to production for export and import-competing productions.

There are, however, widespread criticisms against devaluation in Korea. These criticisms will be now reviewed.

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[2] Kim, Young Chin, and Kwon, Jene K., /10/

2. An Evaluation of Views on Devaluatio

(a) The Factor Proportions Problem

In relation to the so-called "gap model," there is growing suppo of the import minimum thesis which postulates a zero or very low substitutability between imported inputs and domestic resources in develo ing economies. Not only is a relatively fixed proportion of imported inputs to domestic resources needed to maintain existing capacity in operation, but also a relatively fixed proportion of imported capital goods is required for net investment and growth in developing economie Along this line of reasoning, some economists, including Vanek and Lind , hypothesize an import minimum thesis which cannot be solved by varying exchange rates.

In most developing countries, as in advanced countries, however, imports are not confined to raw materials and capital goods. Some imports are, in practice, for consumption. Further, in a strict sense some advanced countries like the U.K. and Japan face the similar facto proportions problem as developing countries do. Hence, it is not an analytical question but a quantitative question.

Professor Cooper studied the experience of twenty-four devaluations involving nineteen different developing countries during the 1955-1966 period.[3] In sixteen cases, absolute imports actually decreased in the year following devaluation. Further, imports may be assumed to rise with domestic income. Hence, the above figure has a serious bias toward underestimating the effectiveness of devaluation in reducing imports. He concludes that the currency devaluation seem

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[3] Cooper, R.N., [7]

to be successful in the sense of reducing imports.

Various quantitative studies have been made to estimate Korea's import function.[4] Although the exchange rate elasticity of import of intermediate goods is quite lower than the exchange rate elasticity of imports of consumption goods, the exchange rate elasticity of Korea's aggregate imports is found to be around -0.7. This indicates that the level of imports is not insensitive to exchange rates and that the so-called import minimum thesis is not in this case empirically valid, although its argument is not insignificant in the sense that the exchange rate elasticity of imports of intermediate goods is found to be quite smaller than the elasticity of imports of consumption goods.

(b) The Export Elasticity Pessimism and/or the Export Maximum Thesis

There has been growing pessimism about the potential for export expansion of developing countries among some economists. Analytically this pessimism is rooted either in so-called "elasticity pessimism" or in the so-called "export maximum thesis".

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[4] Korea's KFX import functions:

(Bank of Korea) $\text{Log } M_{kfx} = -5.03413 + 2.684 \text{ Log } Y - 0.80555 \text{ Log } R_m^*$

(KDI) $\text{Log } M_{kfx} = -2.260 + 1.039 \text{ Log } V - 0.6969 \text{ Log } R_m^*$

where Y, V, and R_m^* respectively stand for gross national product, value-added, and real effective exchange rates of imports.

Korea's sectorial import functions (KDI studies):

$$M_i = 8.0 + 0.84\ V_m - 0.043\ R_m^*$$

$$M_k = 11.3 + 0.87\ FL - 0.298\ R_m^*$$

$$M_d = 120.6 + 0.385\ V_m - 0.340\ R_m^*$$

where M_i, M_k, M_d, V_m and FL respectively stand for imports of intermediate goods, imports of machinery and equipment, and imports for domestic consumption, value added in manufacturing and foreign loans.

Primary exports, in which developing countries are traditionally adept, are subject to a low price elasticity and a low income elasticity of demand in advanced countries. Further, in overpopulated and poorly endowed countries such as in Korea, the supply of primary goods might be too inelastic to provide the export expansion. In addition, producers of simple industrial goods, such as textiles, face limited market outlets and administrative restrictions such as "voluntary" export quotas. In this case, the question arises, why do the developing countries not produce more advanced manufactures which face fewer institutional barriers and are demand-elastic in advanced countries? According to the pessimistic view, great differences in representative demand between advanced countries and developing countries mean that goods demanded in advanced countries are not typically produced for the home market of developing countries. Hence, workers in developing countries lack the skills for the production of these modern manufactures and thus their marginal contribution is very low or even negative in some cases. In addition, the entrepreneurs are unfamiliar with marketing these goods abroad. Thus, it is contended by the pessimists that in developing countries there may be an export maximum for both manufactures and primary commodities. With the former, the maximum is due to domestic-supply conditions resulting from their inexperience and thus low marginal productivity and/or possible cases of negative value added. As for primary products, the exports maximum is determined by inelastic demand conditions

for each of the individual commodities. For example, Linder argues that "no exchange rate at all can make the product more exportable."[5]

The export maximum thesis, however, seems to be exaggerated. Low productivity is a matter of training and education. If labor is available at a low cost and if competitive exchange rates provide incentives for some potentially profitable exports, the technology in use would be improved with the dissemination of knowledge and productivity will be improved. Not all primary exports of the developing countries are subject to low income elasticities and low price elasticities. Oil, nonferrous metals, iron ore, and diamonds are few examples. Hence, the effectiveness of devaluation for increasing export expansion is a quantitative question. According to Professor Cooper's study, nineteen of the twenty-four cases showed export increases in the year following devaluation.[6] Even in these five cases, however, one cannot write off the devaluation as a failure. In the case of India, for example, many exports were adversely affected by the drought, the closure of the Suez Canal, and other exogenous changes. Thus, Professor Cooper concludes that devaluation also seems to work for increasing overall exports in developing countries. A number of other recent studies including works of Devries, Balassa, Larry, and Little-Scitovsky-Scott also present some empirical evidence that total

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[5] Linder, S.B., [illegible]

[6] Cooper, R.N., [illegible]

exports actually performed better in the countries where effective exchange rates were favorable to exports.[7]

Various quantitative studies are made to estimate Korea's export function. These studies show that the coefficient of the effective exchange rate for exports seems positive and highly significant, although the sample period used for the regression is rather short and thus the reliability is limited.

(c) A devaluation-inflation spiral

It has been contended by the pessimists that a devaluation will set off a devaluation-inflation spiral. Especially in developing economies where substitutability between imported inputs and domestic resources is limited, a devaluation will simply raise domestic prices of imported inputs, with little effect on quantity of imports. This will, in turn, cause a progressive rise of domestic prices and thus invite another devaluation. This is an exaggerated account, although the effect of devaluation-induced-inflation cannot be denied. In most of the theoretical literature on devaluation, it has been assumed that a devaluation will increase the domestic prices of importables and exportables not only relative to other prices in the economy but also in absolute amounts. Thus, a price index that includes importable and exportable commodities as well as nontraded goods is bound to show an increase. Indeed, this is the fundamental mechanism that triggers off the first effect of devaluation when we want to cut

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7 Devries, B.A., /8/ Balassa, B., /1/ Larry, H.B., /12/ Little, I.M.D., Scitovsky, T., Scott, M., /15/

down real domestic absorption relative to output, that is, to reduce the trade balance deficit. Professor Harberger, in his recent studies of Argentina and other Latin American countries, concludes that a devaluation of about 50 per cent will probably result in increases of the price level of between 24 and 30 per cent, depending on the values of some key parameters.[8]

Various quantitative studies have been made to estimate the impact of Korea's devaluation on the domestic price level. In the case of a 10 per cent devaluation, devaluation-induced increases in Korea's general price level are reported ranging from 2 per cent (BOK studies) to 3.6 per cent (KDI).[9]

(d) Outstanding Foreign Loans and Political Pressure

Whenever there are large amounts of foreign loans outstanding, a devaluation affects substantially the asset position of firms and individuals who hold large foreign loan liabilities. Thus the firms and individuals who suffer financial losses from the devaluation are likely to exert political pressure against devaluation. The present situation in Korea is a case in point. Further, big firms holding large foreign loans are politically influential. Hence, devaluation becomes a diffi-

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[8] Harberger, A.C., /9/

[9] On the impact of devaluation on the price level in Korea; see (1) Bank of Korea and EPB; the elasticity of the WPI with respect to exchange rate is estimated as about 0.2. (2) Lee, Eric Y., /13/ By using the equation $\Delta P/P = W_2 \times \Delta E/E$, where P is the WPI, W_2 the ratio of imports to GNP and E the exchange rate, the elasticity of the WPI to exchange rate in Korea is reported as about 0.22. (3) KDI Studies; $\Delta P_W/P_W = -0.704 - 0.165\,\Delta V_{na}/V_{na} + 0.232\,\Delta M_s/M_s + 0.363\,\Delta E/E + 0.121\,\Delta P_r/P_r + 0.30\,\Delta P_u/P_u$ where P_W is the WPI, V_{na} value added in non-agriculture-forestry-fishing, M_s money supply, E exchange rate, P_r price of rice, and P_u public utility price.

cult policy measure to implement in Korea. However, Korea's resource allocation should not be jeopardized because of the above transfer problems.

In short, the criticisms against a devaluation are analytically not sound. Empirically, in Korea both imports and exports are fairly elastic with respect to effective exchange rates, although the effect of devaluation-on-inflation is not insignificant.

3. A Summary Appraisal of the Present System

Insofar as particular subsidy or tax rebate incentives have been introduced as substitutes for a devaluation of the exchange rate, they are clearly unjustifiable.

As a first step, exchange rate devaluation should precede the resort to other measures to stimulate exports and to restrict imports. Devaluation has the advantage of being efficient with respect to the relative stimulus which it gives to production for export and import-competing production. While a high exchange rate encourages the substitution of domestic inputs in place of imported inputs to the extent that the former can be produced at a lower opportunity cost, it does not otherwise discourage the use of imported inputs required in the production of more exports, since any given rise in the exchange rate increases the absolute margin measured in domestic currency, separating the gross price of the export product from the gross price of its imported input.

Reliance on control of the level of the exchange rate as the primary stimulus of export expansion possesses the further advantage of making it impossible for the foreign currency proceeds from exports to fall short of the foreign currency cost of the import content of these

exports.

It would seem that there should exist an exchange rate sufficiently high to provide a prospective rate of profit from exports as high as could be provided by any alternative combination of particular subsidies. However, it is true that subsidies on a very large scale might provide a larger initial cash flow to export firms than could be provided by exchange rate policy. For example, large subsidies might finance capital outlays for plant and equipment construction in advance of actual production of exports, whereas a high exchange rate provides rewards only following the acts of production and exportation. On the other hand, it is very doubtful whether subsidies of this magnitude and dating could be justified. They would amount to very large rewards in advance of the performance of the tasks which they were designed to encourage.

However, one valid argument against relying exclusively upon control over the level of the exchange rate is that a high exchange rate gives equal assistance to all export and import competing activities. It does not single out for special assistance those activities where the costs of training labor and management in new skills may fall upon the pioneering firms, but the benefits may be reaped by other firms which at a later date hire away the skilled personnel, or where potential economies of scale promise profits in the future but necessitate initial capital requirements larger than existing financial institutions can be expected to mobilize.

This rationale for selective subsidies would explain and justify all of the subsidy differentials tabulated in Appendix 2 if one could have confidence in the quality of the calculations which determine

the size and duration of each subsidy, and in the quality of the bureaucracy which administers the subsidy programs.

If one lacks this confidence an alternative policy would be to substitute in place of the selective subsidies a higher exchange rate. This would over-expand relatively those export and import-competing activities which are not in the abstract entitled to selective subsidies. In consideration of both trade theory and Korean practice, a reform of Korea's foreign exchange policies should be directed toward a greater reliance on foreign exchange rates for the realization export-promotion and import restriction, while tax-cum-subsidy measures should be simplified and their applications clearly identified to externalities, factor market imperfections, or pioneering and new exporters.

IV. PROPOSALS FOR REFORM OF KOREA'S FOREIGN EXCHANGE POLICIES.

1. Toward More Unified Effective Exchange Rates

As already indicated in this paper, there are substantial differences of effective exchange rates between exports and imports and among different commodities. Such differences are hardly identified with respect to learning effects or new exports. Thus, such differentials cannot be theoretically justified and a reform toward more unified exchange rates is needed. For this purpose, we propose:

(1) To reduce the present magnitude of export subsidies and to simplify the present export measures, and to make export subsidies more proportional to net foreign exchange earnings rather than gross export earnings.

(2) To increase the present level of effective exchange rates on imports with a mix of an increased effective tariff and a reduction of differential tariff-rates for different commodities.

(3) To increase Korea's nominal exchange rate.

Our proposals, however, do not imply that the present tax-cum-subsidy measures should be completely replaced by an adoption of unified exchange rates. Proper tax-cum-subsidies are complementary to unified exchange rates for better resource allocation, internal balance, and external balance by decreased domestic absorption.

(a) On Real Effective Exchange Rates of Exports and Export Subsidies

In consideration of Korea's balance of trade deficit and perplexing balance of payments pressure, rapid export expansion must be continously pursued and maintained. For this purpose real effective exchange rates

of exports must at least be maintained at the 1971 level. However, current export-subsidy measures must be simplified and the magnitude of export-subsidies should be lowered, coupled with an increase in the nominal exchange rate. Further, different rates of export subsidy for different commodities should be moderated.

The Korean government already made some progress toward this direction. Since December 1971 the nominal exchange rate has been gradually increased by "floating". The rate was increased from 370.55 won in early December to 392.90 won at the end of April per U.S. dollar at an average annual rate of 14.47 per cent. Bank loan interest rates were lowered from 24 per cent to 22 per cent in June 1971 and again in January 1972 from 22 per cent to 19 per cent. The lowered interest rates of bank loan mean a reduction of effective export-subsidies per dollar export because the gap between interest rates of preferential loan and bank loan is reduced (see Table 4). Further the policy changes of February 14, 1972, including changes of preferential credit regulations in relation to export activities, effectively reduced credit subsidy per dollar export (see Table 4). In addition, the change of preferential credit regulations made effective export subsidies more proportional to net foreign exchange earnings (see Table 4-A). More recently, rates of wastage allowance which are decided by administrative discretion of Ministry of Commerce have been more strictly applied.

However, such reforms should be further extended in our opinion. In the near future we propose to abolish (i) preferential treatment of corporation and income taxes in relation to export activities, (ii)

the wastage allowance, and (iii) other export subsidies including public utility discounts, D/A, and preferential import licensing of linkage benefits. The imputed results of these proposals are contrasted and summarized in Table 4. Eventually, however, export subsidies should be limited to the clear presence of externalities and "new" pioneering export activities.

(b) On Real Effective Exchange Rates of Imports and Tariff Reform

Since 1965 Korea's real effective exchange rates have been generally decreased due to the extended application of tariff exemptions and concessions. In 1971 the effective tariff rate was less than 6 per cent. This rate is quite low compared to the rates of many other developing countries. To reduce Korea's balance of trade deficit and to increase government revenue which are much needed, Korea's effective tariff rate must be increased to a level of at least 10 per cent. At the same time a tariff reform, including a sharp moderation of tariff exemptions currently in practice, coupled with narrowing differentials of tariff rates for different commodities, is needed. Such proposals are being made by Ministry of Finance along recommendations made by McKinnon and Balassa.[10]

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[10] McKinnon, R.I., /17/ Balassa, B., /2/

Table 4. Comparative Data on Export Subsidies Per Dollar Export

	1970	1971	Changes made in Jan.-Feb. 1972 (imputed basis)		Proposals
1. Interest Subsidies (a+b+c-d)	17.33	12.55		9.83	(9.83)
a. Preferential Export Credit	6.06	6.65	9.62		
b. Preferential Import Credit	6.19	5.30	7.96		
c. Exemption of Predeposit Requirement	5.97	1.50	0.00	0.21	
d. Interest Cost of Predeposit for Import	0.89	0.90	7.75		
2. Internal Tax Concessions (e+f+g)	28.76	35.86		35.86	(30.60)
e. Corporation and Income Tax	3.53	5.25	5.25		To abolish
f. Business Taxes	3.60	3.12	3.12		
g. Commodity Taxes	21.63	27.49	27.49		
3. Liberal Wastage Allowance	12.35	9.66	lower than	9.66	To abolish
4. Other Subsidies Including Utility Discount, D/A, and Preferential Import Licensing	4.09	3.58	3.58	3.58	To abolish
5. Sub-total (1+2+3+4)	62.53	61.65	58.93		(40.43)
6. Tariff Exemptions	42.64	50.89	50.89		
h. Conventional Method 1/					
i. "Modified" Method 2/					
7. Total (1+2+3+4+5)	105.17	112.54	109.82		
j. Conventional Method 1/ (5+h)					
k. "Modified" Method 2/ (5+i)					

Sources: BOK, EPB, and MOF

Notes: 1/ See p.13
2/ See p.13

Table 4-B. Comparative Data on Export-Subsidies and Ratio of Net Foreign Exchange Earnings

Ratio of Net Foreign Earnings(%)	Preferential Export Credit1/		Preferential Import Credit2/		Exemption of Predeposit Requirement 3/		Interest Cost Predeposit for Import4/		Total (1+2+3-4)	
α	1971	R 5/	1971	R 5/	1971	R 5/	1971	R 5/	1971	R 5/
90	10.62	15.36	1.22	1.82	0.34	—	0.21	1.78	11.97	15.40
80	9.44	13.65	2.43	3.65	0.69	—	0.41	3.55	12.15	13.75
70	8.26	11.94	3.65	5.47	1.03	—	0.62	5.33	12.32	12.08
60	7.08	10.24	4.86	7.30	1.37	—	0.82	7.11	12.49	10.43
50	5.90	8.53	6.80	9.12	1.71	—	1.03	8.88	13.38	8.77
40	4.72	6.83	7.30	10.94	2.06	—	1.23	10.66	12.85	7.11
30	3.54	5.12	8.51	12.77	2.40	—	1.44	12.44	13.01	5.45
20	2.36	3.41	9.73	14.59	2.74	—	1.65	14.22	13.18	3.78
10	1.18	1.71	10.44	16.41	3.09	—	1.85	15.99	13.36	2.13
Average of Ratio of Net Foreing Earnings In 1971										
56.38	6.6529	9.62	5.3034	7.96	1.4958		0.8975	7.75	12.5546	9.83

Source: BOK, EPB, and MOF

Notes: 1/ Preferential Export Credit = α x won per dollar allowance for preferential credit x Difference of interest rate(%) x Days allowed for preferent loan (90/360)

(1971) = α x 295 x (22-6) x (135/360)

($\bar{R}$) = α x 350 x (19-6) x

2/ Preferential import credit	=	(1 - α) x	Selling rate	x	Difference of interest rate (%)	x	Days allowed for preferencial loan	
(1971)	=	(1 - α) x	374.1	x	(22-9)	x	90/360	
(R)	=	(1 - α) x	374.1	x	(19-6)	x	135/360	

3/ Exemption of predeposit requirement	=	(1 - α) x	Selling rate	x	Interest rate on loans (%)	x	Days allowed for exemption predeposit
(1971)	=	(1 - α) x	374.1	x	22	x	15/360

4/ Interest cost of predeposit for import	=	(1 - α) x	Selling rate	x	Interest rate on loans (%)	x	Rate of required predeposit (%)	Days required for predeposit
(1971)	=	(1 - α) x	374.1	x	22	x	10	90/360
(R)	=	(1 - α) x	374.1	x	19	x	100	90/360

5/ The figures in R columns are based on reforms made in Jan.-Feb., 1972

2. Practical Approaches to Estimate Korea's Proper Exchange Rates

Prior to discussing Korea's equilibrium exchange rates, crude but practical approaches will be used in estimating Korea's proper exchange rates in the context of international competitiveness and balance of trade.

(a) Various Parity Rates

(1) Purchasing-power parity rate. Suppose to maintain the 1965 level of purchasing-power parity. Without considering the effective won depreciation resulted from the Big Ten Agreement last December, Korea's nominal exchange rate at the end of 1971 should be at 401.50 won to a dollar and by the end of 1972 Korea's nominal exchange rate should be at 422.87 won or 434.31 won depending on Korea's inflation rate in 1972 (see Table 5). By accounting the effective won depreciation last December, Korea's parity exchange rates at the end of 1972 should be lower at 396.89 won or 408.33 won depending on Korea's inflation rate (see also Table 5).

(2) Adjusted parity rates. If we use adjusted parity indexes instead of purchasing-power-parity indexes, nominal exchange rates to maintain the 1965 parity level are slightly lower as shown in Table 5.

(3) In terms of real wage and per capita products in manufacturing industries between 1965 and 1970, Korea's competitiveness has been relatively weakened compared to Japan while it has been relatively improved compared to the U.S. (See Table 5).

(b) Real Effective Exchange Rates

For the continous export expansion which is vital for Korean economy, the real effective exchange rate on exports must be at least

Table 5. Comparative Parity Rates for 1965-1972

	1965	1966	1967	1968	1969	1970	1971	1972 1/	1972 2/
1. Nominal Exchange Rates	271.78	271.18	274.60	281.50	304.45	316.65	373.30	-	-
2. Purchasing Power Parity (ppp)									
(a) ppp index (1965=100)	100.0	93.85	88.74	83.65	81.29	75.44	67.69	64.27	62.50
(b) Parity nominal rates 3/	271.78	289.59	306.27	325.01	334.33	360.26	401.51	422.87	434.31
(c) Parity nominal rates 4/	-	-	-	-	-	-	-	396.89	408.33
3. Adjusted Parity Rates (APR)									
(a) Adjusted parity index on exports 5/	100.00	92.52	88.63	84.21	82.17	76.99	69.35	-	-
(b) Adjusted parity index on imports 6/	100.00	94.12	88.79	84.32	81.82	75.61	67.58	-	-
(c) Average adjusted parity index (AAP)	100.00	93.32	88.71	84.27	82.00	76.30	68.47	68.47	63.07
(d) Parity nominal rates 3/	271.78	291.23	306.37	322.51	331.44	356.20	396.93	419.54	430.92
(e) Parity nominal rates 4/	-	-	-	-	-	-	-	393.56	404.94
4. Comparative Real Wages in Manufacturing									
(a) Real wage parity index 7/	100.00	93.54	96.89	99.63	86.03	83.38	-	-	-
(b) Real wage index (RWI) in manufacturing									
Korea (RWI^K)	100.00	114.44	116.96	124.02	158.58	176.82	208.59	-	-
Japan (RWI^J)	100.00	106.2	115.6	126.1	139.5	152.4	163.3	-	-
U.S.A. (RWI^U)	100.00	107.93	110.61	120.89	132.79	142.13	-	-	-
5. Per Capita Product Index in Manufacturing									
Korea	100.00	108.44	110.37	124.76	147.42	168.57	196.50	-	-
Japan	100.00	110.54	125.68	142.21	161.55	183.60	192.36	-	-
U.S.A.	100.00	101.50	100.14	105.07	106.16	106.28	-	-	-

Sources: Bank of Korea, Monthly Economic Statistics, U.S. Government, Economic Report of The President, Jan. 1972. Bureau of Statistics, Japan, Monthly Statistics of Japan, Feb.1972

Notes: 1/ Projected inflation rates in 1972 are assumed as follow; Korea(10%), Japan(5.0%) U.S.A. (3.2 %)

2/ Alternatively, Korea (13 %), Japan (5.0 %), U.S.A. (3.2 %).

3/ The effective won depreciation resulted from the Big Ten Agreement last December was not accounted.

4/ The effective won depreciation resulted from the Big Ten Agreement last December was accounted.

5/ and 6/ See Table 1

7/ The formula used is $(RWI^U \times W^U + RWI^J \times W^J)/RWI^K$, where U, J, K, and W respectively stand for U.S.A., Japan, Korea, and country's trade share to Korea's total trade.

maintained at the present level. As far as Korea's inflationary rate is projected greater than that of major trading countries, devaluation of Korea's nominal exchange rates is therefore needed, preferably coupled with a reform of present export-subsidy measures. Effective exchange rate of export by using our modified viewpoint was about 447.46 won to a U.S. dollar in December 1971.[11] To Maintain this level of real effective exchange rate on exports, the nominal exchange rate in December 1972 is computed as follow: $R_n = (447.46 \times WPI_k/WPI_f) - W_d$ where R_n is nominal exchange rate in December 1972, WPI_k wholesale price index of Korea, WPI_f weighted wholesale price index of major trading countries, and W_d effective won devaluation resulted from Big Ten Agreement last December. That is, $R_n = 447.46 \times 110/104.1 - 25.98 = 446.84$.[12] Alternatively $R_n = 447.46 \times 113/104.1 - 25.98 = 459.74$.[13] The above figures are, however, computed on the assumption of adopting our proposed reform of export-subsidy measures. If the proposed reform is delayed, the minimum level of nominal exchange rate can be justified at a lower rate.

(c) The Third Five-Year Plan

To meet the 1972 targets of the Third Five-Year Plan, however, the real effective exchange rate itself should be increased in 1972. This is illustrated in Table 6 below by using various assumptions.

3. <u>Transitional Problems-Devaluation by "Folating" or Once-and-for-all Devaluation</u>

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11 See pp. 13-15 and Table 3 in this paper.

12 Korea's inflation is assumed at 10 per cent for 1972 and see Table . for 25.98 won.

13 Alternatively Korea's inflation is assumed at 13 per cent.

Table 6. Required Increase of Real Effective Exchange Rates to Meet the Third Five-Year Plan

Target increasing rates		Required increase of exchange rates		Real effective exchange rates on exports in 1971 (won)	Required real effective exchange rates on exports in 1972 (won)	
ΔY (%)	ΔX(%)	ΔR^*_{re} (%) 1/				
9	27	9.44 3/	4.42 4/	447.46	489.70 3/	467.24 4/
9	33	11.80	6.78	447.46	500.26	477.80
8	27	9.57	4.55	447.46	490.28	467.82
8	33	11.94	6.92	447.46	500.89	478.42
7	27	9.71	4.69	447.46	490.91	468.45
7	33	12.07	7.05	447.46	501.47	479.00

Target increasing rates		Required increase of exchange rates		Real effective exchange rates on imports in 1971 (won)	Required real effective exchange rates on imports in 1972 (won)	
ΔY (%)	ΔM_{kfx}(%)	$\Delta R/pp$(%) 2/				
9	3.4	8.2 3/	0.37 4/	405.26	438.49 3/	406.76 4/
9	0	13.8	5.97	405.26	461.19	429.45
7.3	0	11.2	3.37	405.26	450.65	418.92

Notes: 1/ The formula used is $X = -1{,}003.6323 + 0.3400\ Y + 2.5367\ R^*_{re}$
(Frank-Kim-Westphal's formula)

2/ Imports function of KDI, $\text{Log } M_{kfx} = 2.260 + 1.039 \text{ Log } Y - 0.6968 \text{ Log } R/pp$, is used.

3/ The figures are computed without considering the effective won depreciation resuled from the Big Ten Agreement.

4/ The figures are computed with considering the effective won depreciation resulted from the Big Ten Agreement.

Since there is abundant economic literature on the question of floating versus fixed rates,[14] our discussion will merely review some institutional and political constraints in Korea if we are to devalue the Korean won. If Korea's nominal exchange rate is in the neighborhood of its shadow rate, adjustment of exchange rates by floating is adequate and preferable. If the gap between proper exchange rate and actual rate is substantial, however, gradual devaluation by floating is subject to many constraints. First, the rate of devaluation by floating cannot exceed the Korean interest rate. Otherwise, Korean exporters may gain a greater rate of return by postponement of their export Suppose Korea were to devalue her currency by floating at an annual rate of 15 per cent in consideration of the interest rate constraint. As shown in Table 7 below, it is difficult for Korea's nominal exchange to approach even our "reference" rate. Secondly, such a gradual devaluation is subject to political constraints. The firms and individuals who suffer financial loss from the devaluation will exert political pressure with increasing intensity. Especially when it comes near to the election time, the gradual devaluation becomes practically out of consideration in view of past experiences in Korea. Further, the transfer problem in relation to devaluation and repayment of foreign loans can be more easily tackled by once-and-for-all devaluation than through a gradual devaluation by floating. In consideration of these institutional and political constraints, once-and-for-all devaluation is preferable and more practical than a gradual devaluation by floating.

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[14] Bergsten, C.F., Halm, G.N., Machlup, F., and Rossa, R.V., [illegible]

Table 7. Projected Parity Exchange Rates by Floating

	1971	1972	1973	1974
Nominal Exchange Rates 1/	373.3	418.10	468.27	524.46
Purchasing-Power-Parity (PPP) Exchange Rates	373.3	395.69	419.38	444.53
(Purchasing Power Parity Index) 2/	(100)	(94.64)	(89.56)	(84.76)
The Gap between PPP Exchange Rates and Reference Exchange Rates of 447.46 won to the U.S. dollar 3/	74.16	51.77	28.08	2.93

1/ Projected Devaluation Rate of Korean Won

1972	1973	1974
12%	12%	12%

2/ Projected Annual Rate of Inflation

	1972	1973	1974
Korea	10%	10%	10%
Major Trading countries	4.1%	4.1%	4.1%
(U.S.)	3.2%	3.2%	3.2%
(Japan)	5.0%	5.0%	5.0%

3/ Reference exchange rate of 447.46 won to the U.S. dollar at the end of 1971 is based on the "modified" effective exchange rate of export at the end of 1971. (See Table 3)

4. The Equilibrium Exchange Rate-A Simple Model

The equilibrium exchange rate is defined as the rate which can maintain both internal balance and external balance. The existence of such an equilibrium rate in developing economies has been questioned by the so-called gap theory. Our model below will show that such equilibrium rate exists even with the special assumptions of the gap theory.

(a) Assumptions

(i) Two goods, X and Y: Y is tradable and X is not tradable [15]

(ii) Two inputs, domestic resources (D) and imported resources (M)

(iii) X can be produced either with inputs of D only or of D and M, but the production of Y requires a certain amount of M. By and large the production of Y requires a larger input proportion of M than does the production of X.

(iv) The economy is small enough to assume its import prices (P_m) as given: that is, $P_m = \bar{P}_m$.

(v) Other conventional assumptions including homogenous production functions, pure competition, and zero transportation costs.

(b) A Simple Static Model

In this section we further assume that labor is the only domestic resource and that the quantity of labor avaiable to the economy is fixed (I). For simplicity we also assume that there is no foreign capital

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[15] In a strict sense, X is tradable but the prospects for expansion of export earnings on X are so dim that we can ignore them, which comes close to the assumption that X is not tradable.

flow. The prices of $Y(P_y)$, of $X(P_x)$, of imported inputs (P_m), and of domestic labor (W/R) are expressed in terms of foreign currency, where W and R respectively stand for price of domestic labor in terms of the home currency and the exchange rate.

We now examine whether both internal balance and external balance can be compatible at some level of W/R. This can be analyzed in terms of two curves: the foreign demand curve for domestic labor (denoting as L_F) implicit in the foreign demand for Y, and the derived supply curve of domestic labor to foreigners (denoting as L_S) which is implicit in the supply quantity of exports required to achieve domestic full employment. Thus L_F is the quantity of domestic labor which is indirectly demanded by foreigners at each value of the ratio W/R when foreigners buy our exports (Y_F) L_S is the quantity of domestic labor which is supplied to the foreigners at each value of the ratio W/R; that is, $L_S = \bar{L} - L_H$, where L_H stands for the quantity of labor demanded at home under conditions of full employment of domestic labor. In other words the fixed quantity of labor available to the economy $(\bar{L})$ must be either demanded at home (L_H) or demanded by foreigners (L_F) in order to have internal balance.

Since the price of the imported input is still assumed to be fixed in terms of foreign currency, and since the marginal rate of technical substitution of domestic resource for imported inputs has to be equal to the ratio of factor prices for cost minimization, it is obvious that the variable determining the optimum factor mix is the ratio W/R. Hence, the production coefficients l_x, l_y, m_x and m_y are all functions of w where w is defined as W/R.

$$l_x = l_x(w),\ l_y = l_y(w),\ m_x = m_x(w),\ m_y = m_y(w) \qquad (1)$$

Furthermore, given w, all production coefficients are uniquely determined when we assume that the functions, $l_x(w)$ and $l_y(w)$ are strictly decreasing while the functions, $m_x(w)$ and $m_y(w)$ are strictly increasing. Once a one-to-one correpondence has been established between w and the production coefficients, it is easy to show that both the foreign demand curve for domestic labor and the supply curve of domestic labor to foreigners are determined by the ratio W/R.

(i) The Foreign Demand Curve for Domestic Labor (L_F) Induced by Foreign Demand for Y

L_F can be expressed by the equation:

$$L_F = l_y Y_F$$
$$= l_y(w) \times Y_F(P_y) = l_y(w) \times Y_F f(w) \qquad (2)$$

where the function $Y_F(P_y)$ is the foreign demand for Y. P_y is a strictly increasing function of w since P_m is assumed constant. If w goes up Y_F goes down since P_y goes up. Hence, the foreign demand curve for domestic labor is a strictly decreasing function of w. Thus, differentiating equation (2) with respect to w, we obtain

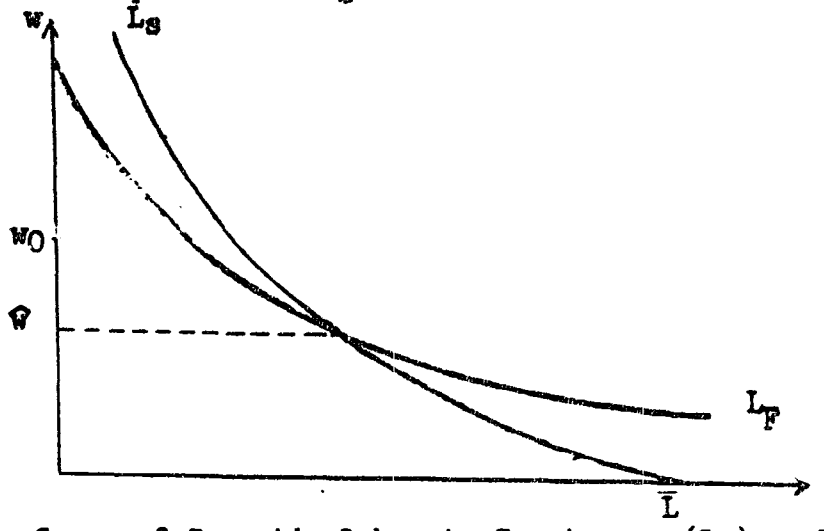
$$\frac{dL_F}{dw} = Y_F \frac{dl_y}{dw} + l_y \frac{dY_F}{dP_y} \qquad (3)$$

Equation (3) shows that the negative slope of the function (L_F) is due to more intensive use of domestic resource and an increase of Y_F when w is lowered.

Exploring the shape of the L_F function further, it is of interrest to discover whether it has a finite intercept with both the w-axis and the L-axis. The foreign demand curve for domestic labor (L_F) will have a finite intercept with the w-axis when Y_F becomes zero or when l_Y becomes zero as w increases. This can be easily verified by looking at equation (2). Since the fact that Y_F becomes zero at sufficiently high values for w and P_y is self-evident, we can conclude that L_F will necessarily have a finite w-axis intercept. In other words, if w is sufficiently raised, P_y would become high enough to choke off all foreign demand for Y and thus for domestic labor. This conclusion is valid independent of the degree of substitutability between domestic resources (L) and imported input (M). On the other hand, the foreign demand for domestic labor will have a finite L-axis intercept only if both Y_F and L_F tend to finite values as w tends to zero. If we assume limited substitutability between L and M, L_F could be finite even when w tends to zero. But, as w tends to zero, values of Y_F may become relatively large, consideraing the relative scale of a small domestic economy in the large world economy. In general, hence, when we consider a small economy (and allow some substitutability between L and M) the foreign demand curve for domestic labor will approach the L-axis asymptotically as w tends to zero. In short, the foreign demand curve for domestic labor is generally a decreasing function of

w, with a finite w-axis intercept and approaching the L-axis asymptotically. This is depicted in Figure 1.

Figure 1.



(ii) The Supply Curve of Domestic Labor to Foreigners (L_s) implicit in the supply of exports needed to maintain domestic full employment.

L_s is expressed by the equation:

$$L_s = \bar{L} - L_H \qquad (4)$$

L_H is determined by the equation:

$$L_H = l_x X_H + l_y Y_H \qquad (5)$$

where X_H and Y_H stand for the quantities of X and Y consumed at home, the quantities of X_H and Y_H being chosen at the point where the community budget line is tangent to the highest possible social indifference curve.

The community budget line is determined by the full employment income of ($w\bar{L}$).

Since X_H and Y_H are, with a given social indifference map, constrained by the full employment community budget line

$$w\bar{L} = P_x X_H + P_y Y_H$$

$$= (wl_x + P_m m_x)X_H + (wl_y + P_m m_y)Y_H$$

$$\bar{L} = (l_x + \frac{P_m m_x}{w})X_H + (l_y + \frac{P_m m_y}{w})\ Y_H$$

$$= (\frac{P_m}{w} m_x)X_H + (\frac{P_m}{w} m_y)Y_H + l_x X_H + l_y Y_H$$

$$= \frac{P_m}{w}\ (m_x X_H + m_y Y_H) + L_H \qquad (6)$$

Now we can derive an interesting derived supply curve of L_s:

$$L_s = \bar{L} - L_H$$

$$= \frac{P_m}{w}(m_x X_H + m_y Y_H)$$

or

$$wL_s = P_m(m_x X_H) \qquad (7)$$

Equation (7) simply states that the value of domestic labor supplied to the foreigners in terms of foreign currency (wL_s) equals to the value of imported inputs indirectly consumed at home $P_m(m_x X_H + m_y Y_H)$. Hence, when L_s intersects L_F both internal balance and external balance can be reached.

Now let us examine the shape of L_s. When w is zero, L_s intersects the L-axis at a distance from the origin equal to $\bar{L}$ simply because L_H would be zero with w = 0. On the other hand, as w tends to infinite, L_s approaches the w-axis asymptotically. This is so because the economy can obtain large amounts of imported inputs in exchange for small quantities of domestic labor. The shape of L_s between these two limits should be attributed to the characteristics of the social indifference map and the isoquant map. In general L_s would decrease as w increases;

that is, L_s is backward bending with the L-axis intercept at $\bar{L}$. This is depicted in Figure 1 above.

(iii) Existence of Equilibrium and Policy Implications

Since L_s approaches the w-axis asymptotically with a finite L-axis intercept, and L_F approaches the L-axis asymptotically with a finite w-axis, L_s and L_F must intersect and thus both internal balance and external balance must occur at some positive value of w.

(c) A Tentative Outline to Be Pursued

(i) An Extension of Our Simple Model with More Realism

(ii) Empirical Investigations along Our Model

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CONSTRUCTING A LABOR PRODUCTIVITY INDEX IN THE MINING AND MANUFACTURING SECTORS OF THE KOREAN ECONOMY

Dai-Young Kim

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PREFACE

This paper is one in the series of continuing KDI research works which is designed to aid in the formulation of sound public policies and to promote public understanding of issues of the Korean economy.

This paper is a part of our on-going research which will construct ideal productivity indexes from existing statistical data, analyze their trends and compare them with other economic indicators. The main purpose of this study is to assist economic researchers in analyzing productivity trends in the mining and manufacturing sectors of the Korean economy. It is hoped that this paper will help to stimulate the exchange of useful knowledge for future improvement.

The interpretations and conclusions in this paper are those of the author or authors and do not represent the views of the Korea Development Institute. Finally, I would like to extend our appreciation to those within and outside of this Institute who have participated in these endeavours.

Mahn Je Kim
President

CONSTRUCTING A LABOR PRODUCTIVITY INDEX IN THE MINING AND MANUFACTURING SECTORS OF THE KOREAN ECONOMY

by

Dai Young Kim*

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Appendix I. Influencing Factors on the Change of Index [illegible]
Appendix II. Comparison of Labor & Capital Productivity Index [illegible]

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I. INTRODUCTION

The purpose of this paper is to assist economic researchers in analyzing productivity trends in the mining and manufacturing sectors of the Korean economy.

In general, "productivity" is a measure that represents a relationship between output and the total input of factors required to produce it. Because it is not easy to measure the total input of factors, a specific measure of productivity expressed as the ratio between a given measure of output and that of a specific factor interest has been studied by many researchers (called average productivity).

A broad definition of labor productivity is the ratio between output and labour input required. Such a broadly defined notion of productivity is studied in this paper, not labour productivity as defined in the marginal concept. Usually the different methods of measuring labor productivity are classified according to the different measures of output and labor input used. Moreover, for a labor productivity index, the level of disaggregation and the method of aggregations, and the choice of base year are main influencing factors. The use of any particular combination of the above mentioned parameters depends on the purpose of measurement and the available statistical data.

While output is assumed to be a function of capital, labor and technology etc., changes in labor productivity will be caused by any

combination of changes in capital, labor, or technology, etc. Similarly, changes in a labor productivity index will be caused by any combination of changes in the amounts of capital and labor used between two points in time. (See Appendix I.)

As the main concern of this paper is not the theoretical aspects of productivity but the construction of an ideal labor productivity index from existing statistical data, most of the analysis is computational.

In Chapter II, the methodology of formulating labor productivity and the corresponding index is studied. From the available statistical data, various labor productivity indexes are constructed, their trends and characteristics examined, and the selection of an ideal index from these various indexes are studied in Chapter III. Also, labor productivity indexes are compared with other economic indicators such as wage index.

1. Sources of Data.

The annual labor productivity indexes computed in this paper are based on the Mining and Manufacturing Census (or Survey) for the period 1966-1970. The quarterly index, which uses 3rd quarter 1970 productivity as the base level, is constructed from the monthly survey carried on by Bureau of Statistics (BOS).

The annual survey, covering all establishments employing 5 or more persons, is supposed to maintain the basic data continuously in an annual time series and to clarify the level of production and the industrial structure in the mining and manufacturing sectors. The

data of this survey are only available approximately 15 months after the year ends. This has been carried on by Korean Reconstruction Bank(66 - 67), by The Korea Development Bank(68) and by BOS(69 - 70). The KSIC(Korean Standard Industrial Classification) used for 1966-1969 survey is disaggregated up to the 6-digit level, while it is disaggregated to the 7-digit level for 1970 on. The economic data for establishments are available only at the 4-digit level in 1966-1969 and at the 5-digit level from 1970 on. Both levels, however, represent the same level of establishment. To avoid difficulties arising from the different level of aggregation in the basic units of observation in the time series under study, an attempt is made to derive a new set of economic variables at the 5-digit level corresponding to the 1970 unit of observation, by giving output as a weight.

To maintain current information a monthly survey is performed which provides a preliminary estimate of the annual survey. The survey is based on individual firms, which were selected in the following manner : First, of the more than 1,500 commodities listed in the KSIC (of the annual survey), 333 commodities, the value of whose output represents approximately 90 % of total mining and manufacturing output, were selected as the basis of the survey. About 6,500 of the largest producers of these commodities were then selected as the actual sampling. For each firm surveyed, only the output of commodities on the short list(of 333 commodities) was counted, along with the total labor input.

1.1. Construction of Deflators and Unit Prices.

At the monthly survey, most commodities on the short list are surveyed in terms of physical volume (case 1), while the rest are surveyed in terms of monetary value (case 2). For commodities in case 1, appropriate unit prices are derived from the annual survey of 1970, while appropriate deflators are derived from the wholesale price index for commodities in case 2.

The prices of output at the 5-digit industry level in the annual survey are current prices. To convert them into constant prices deflators are needed. Deflators for 250 5-digit industries are constructed based on the wholesale price index as follows : 606 commodities which are covered in the wholesale price survey are matched to the corresponding 250 5-digit industries. Suppose H_{i1}, ... , H_{in} are the wholesale price indexes of the commodities corresponding to industry i (with their weights W_{i1}, ... , W_{in}). The following cases are considered :

Case 1.

If $n=1$, then let H_i, the price index of the industry i, be

$$H_i = H_{i1} .$$

case 2.

If $n \geq 2$, then

$$H_i = \sum_{j=1}^{n} H_{ij} W_{ij}$$

case 3.

If $n=0$, then the index for the next higher level is computed and this estimated index is used for H_i .

2. Notation.

The symbols O^t_{ijklm} , V^t_{ijklm} and L^t_{ijklm} denote the real value of production, the real value added and the number of persons employed respectively in year t for a KSIC 5-digit industry (the subscript i for a 1-digit, ij for a 2-digit, ... , $ijklm$ for a 5-digit classification).

For a given sequence of variables X_{ijklm} , $m=1,\ldots,M_l$, $l=1,\ldots,L_k$, $k=1,\ldots,K_j$, $j=1,\ldots,J_i$, $i=1,\ldots,I$, the symbols X_{ijkl+} , X_{ijk++} , ... and X_{+++++} are used for $\sum_m X_{ijklm}$, $\sum_l X_{ijkl+}$, .. and $\sum_i X_{i++++}$, respectively. P^t_{ijklm} , P^t_{ijkl} , ... and P^t are used for the labour productivity index at a 5-digit level, 4-digit level, ..., and at a fully aggregated level at year t, respectively.

II. METHODOLOGY

Productivity indexes are required for many types of economic analysis. Researchers often try to use one that best strengthens their own purpose (for example, an index for or against a particular wage policy etc.).

In section 1, three different groups of methods for constructing labor productivity indexes are introduced. In section 2, different measurements of input, output and weights are discussed. In section 3, verbal expressions introduced in section 1 and 2 are specified in formulas. A brief discussion on the ideal labor productivity index appears in section 4.

1. Groups of Labor Productivity Indexes.

As any measure to compare two distinct points in time (or in space) may be represented in various forms, a number of general approaches may be taken in constructing a labor productivity index :

Group 1.

At the lowest level, a labor productivity index may be defined as the ratio of output per labor input for the current period to that for the base period. The individual (lower) level indexes are then aggregated with given weights for the higher level index.

Group 2.

At each level, a labor productivity index may be defined as the ratio of an output (production) index to a labor input index.

Group 3.

At each level, a labor productivity index may be defined as the ratio of current to base period labor productivity.

Remarks.

A labor productivity index defined as the ratio of output per labor input for current period to that for base period is a member of Group 3 (called the output per labor input ratio, and this is generally used by many countries).

Productivity series calculated in absolute figures are naturally affected by the choice of the measures of output and input. However, in Chapter III we see that the influence seems to be negligible in many cases when they are converted into an index.

2. Measurements of output, input and weight.

2.1. Measurements of output.

When the lowest level of disaggregation formulating a labor productivity index is the commodity level, a physical units may be used as a measure of output. However, homogeneity of all items is hardly to be expected at a given period or in two different time periods. This is the difficulty involved in using physical terms for output measurements. Due to the effects of rapidly developing technology, as seen in Korea, in most industries the commodities produced are generally not homogeneous with respect to time. Moreover, actual survey information is generally sampled at level of

the establishment, where multi-production is performed and decomposition of labor into production of various commodities is not easy. This requires that we use money terms for the measurement of output.

The two main candidates for output measurement are value added and the volume of production. By using value added as a measurement of output, double-counting the labor content can be avoided. By taking the ratio of production per head in two different periods, however, the effect of double-counting is canceled out substantially. (See Table 3 in chapter III.)

2.2. Measurement of Input.

Either labor hours or the number of persons contributing to the production of a given level of output may be used for measuring the level of labor input. Conceptually, for short term projections, the number of hours actually worked is undoubtedly the most suitable measure for forecasting labor productivity, while the number of persons employed would probably be preferable for long term projections (for example, projecting employment trends)[1]. Simply adding up the number employed or hours worked ignores the labor quality aspect. To use weights based on wages, the interchangeability of labor among different sectors should be assumed. It seems that such a weighting procedure would result in an index for "paid wage productivity" rather than for labor productivity. The overall value of the level of

[1] See [2, PP. 20].

labour productivity at the national level can only be obtained if it relates to the total national labour force.

The type of labor coverage, whether it consists only of direct labor or all (direct and indirect) labor, must be determined in advance. The latter concept is employed in this paper[2].

2.3. Choice of Weight.

Weights for aggregating the lower level labor productivity indexes to a higher level may be chosen from among the following :

i) Volume of production in base (Laspeyres) or current (Paasche) period.

ii) Volume of value added in base or current period.

iii) Volume of labor in base or current period.

iv) Volume of production by current (base) labor assuming base (current) labor productivity.

v) Volume of labor required to produce current (base) output assuming base (current) requirement.

Above are among the most simple and reasonable weights, although many others could be constructed.

3. Formulas of Labor Productivity Index.

The labor productivity indexes at the level of 5-digit industry and up described verbally in section 1 are formulated according

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[2] The study of labor productivity indexes using various measures for labour input remains for our further study.

to the various choices of measures discussed in section 2 as follows :

Group 1.

$$P^t_{ijklm} = (O^t_{ijklm} / L^t_{ijklm}) / (O^o_{ijklm} / L^o_{ijklm})$$

$$\text{or} \quad P^t_{ijklm} = (V^t_{ijklm} / L^t_{ijklm}) / (V^o_{ijklm} / L^o_{ijklm}) ,$$

$$P^t_{ijkl} = \sum_m P_{ijklm} (W_{ijklm} / W_{ijkl+}) ,$$

$$\vdots$$

$$P^t = \sum_i P^t_i (W_{i++++} / W_{+++++}) ,$$

where the choices of W_{ijklm} are given in section 2, i.e.,

i) $W_{ijklm} = O^o_{ijklm}$ or O^t_{ijklm} ,

ii) $W_{ijklm} = V^o_{ijklm}$ or V^t_{ijklm} ,

iii) $W_{ijklm} = L^o_{ijklm}$ or L^t_{ijklm} ,

iv) $W_{ijklm} = O^o_{ijklm} (L^t_{ijklm} / L^o_{ijklm})$ or

$O^t_{ijklm} (L^o_{ijklm} / L^t_{ijklm})$,

v) $W_{ijklm} = L^o_{ijklm} (O^t_{ijklm} / O^o_{ijklm})$ or

$L^t_{ijklm} (O^o_{ijklm} / O^t_{ijklm})$.

Note.

The superscript, o, indicates the base period.

Group 2.

At each level a output index (denoted by A with subscripts) and input index (B with subscripts) at period t may be defined as follows :

$$A^t_{ijklm} = O^t_{ijklm} \;/\; O^o_{ijklm} \text{ or } V^t_{ijklm} \;/\; V^o_{ijklm} ,$$

$$A^t_{ijkl} = \sum_m A^t_{ijklm} \left(W_{ijklm} \;/\; W_{ijkl+} \right) ,$$

$$\vdots$$

$$A^t = \sum_i A^t_i \left(W_{i++++} \;/\; W_{+++++} \right) ,$$

where W_{ijklm} may be chosen among i) and ii).

$$B^t_{ijklm} = L^t_{ijklm} \;/\; L^o_{ijklm} ,$$

$$B^t_{ijkl} = \sum_m B^t_{ijklm} \left(W_{ijklm} \;/\; W_{ijkl+} \right) ,$$

$$\vdots$$

$$B^t = \sum_i B^t_i \left(W_{i++++} \;/\; W_{+++++} \right) ,$$

where $W_{ijklm} = L^o_{ijklm}$ or L^t_{ijklm} .

Now we are in position to formulate

$$P^t_{ijklm} = A^t_{ijklm} \;/\; B^t_{ijklm} ,$$

$$P^t_{ijkl} = A^t_{ijkl} \;/\; B^t_{ijkl} ,$$

$$\vdots$$

$$P = A / B.$$

Group 3.

Labor productivity at the various levels of aggregation in the period t may be defined as

$$C^t_{ijklm} = O^t_{ijklm} / L^t_{ijklm} \text{ or } V^t_{ijklm} / L^t_{ijklm} ,$$

$$C^t_{ijklm} = \sum_m C^t_{ijklm} (W_{ijklm} / W_{ijkl+}) .$$

$$\vdots$$

$$C^t = \sum_i C^t_i (W_{i+++++} / W_{+++++}) ,$$

where W_{ijklm} may be chosen among i) and ii). So that

$$P_{ijklm} = C^t_{ijklm} / C^o_{ijklm} ,$$

$$P_{ijkl} = C^t_{ijkl} / C^o_{ijkl} ,$$

$$\vdots$$

$$P = C^t / C^o .$$

When $C^t_{ijklm} = O^t_{ijklm} / L^t_{ijklm}$ and $W_{ijklm} = O^o_{ijklm}$,

the resulting index is simply the index of output per laborer.

Note on weights.

The weight in iv) is the level of output multiplied by the labor ratio, which is counted in the individual productivity index.

In other words, the labor ratio is counted twice for the lower level labor productivity index and for the weight of aggregation to the higher level index. So are the weight in v). Therefore iv) and v) are not selected as ideal weights.

Ideal Indexes

In section 3, about 40 different indexes[3] of three different groups are introduced, and others are still possible. To select ideal indexes from the above, the availability of statistical data and some of the criteria of an ideal index must be considered.

The main conceptual difference between an index of Group 1 and that of Group 2 (or Group 3) is that the former is a weighted sum of ratios while the latter is a ratio of the weighted sums. Even slight errors in each index of output and input will sometimes combine to produce considerable errors in the ratio, just as they will sometimes cancel out[4]. Some authors want the labor productivity index to be the ratio of the output index to the labor input index, and that the forms of the three indexes be homologous in structure, such as weighted average of corresponding relatives[5]. These two requirements can hardly be satisfied simultaneously, i.e., any resulting index in Group 2 can hardly be a form of weighted average.

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[3] A number of these indexes are also mentioned by R. Harris [3] in a different context.

[4] See Fabricant [1, PP. 16] .

[5] See Siegel [4, PP. 26] .

By using a procedure to allow a ready combination of the lower level indexes for the higher level index, the cause of a change in the labor productivity index at a certain period and level can be identified more easily[6]. Among the 3 groups mentioned, in this sense, an index in Group 1 is ideal. The labor productivity indexes (relative labor productivities) of the lowest levels are aggregated through the intermediate levels to the total index. As long as the labor productivities of the lower levels of disaggregation are unchanged, which is hardly to be expected in the real world, the labor productivity index of the higher level remains unchanged. This type of index eliminates that portion of an increase in total aggregate output per laborer purely due to changes in the proportions of total output or total labor force associated with particular industries, assuming that output per head in each individual industry increases at the same rate.

Given indexes, $P^t_{ijkl1}, \ldots, P^t_{ijklM}$ for the M industries at the 5-digit level, suppose we want an index at the 4-digit aggregated level, say P^t_{ijkl}. A criterion for an ideal index may be:

$$\min_{1 \leq m \leq M} P^t_{ijklm} \leq P^t_{ijkl} \leq \max_{1 \leq m \leq M} P^t_{ijklm} .$$

In words, a higher level index should be greater than or equal to the minimum, and less than or equal to the maximum, of the corresponding lower level indexes.

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[6] This is demonstrated in section 4.4, Chapter III.

According to this criterion, an index in Group 1 is preferable to an index in Group 2 or Group 3[7]. For the case M=2, we can demonstrate this easily :

4-digit industry	5-digit industry	1966		1967	
		# of employment	value of output	# of employment	value of output
3201	32015	1	2	1	2
	32016	2	10	3	18

By using consistent measurements of input and output, indexes at the 5-digit level are the same for all three groups, namely

$$P^{1967}_{32015} = 100, \quad P^{1967}_{32016} = 120.$$

Taking the value of output in 1966 as a weight, we obtain an index in Group 1,

$$P^{1967}_{3201} = 100 \times \frac{2}{12} + 120 \times \frac{10}{12} = 116.7.$$

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[7] This follows from the following mathematical fact,

$$\min_{1 \le i \le M} X_i \le \sum_{i=1}^{M} X_i W_i \le \max_{1 \le i \le M} X_i ,$$

for given real numbers X_i , i=1, ... , M, $W_i \ge 0$, i=1, ... , with $\sum_{i=1}^{M} W_i = 1$.

Taking the value of output in 1966 as a weight for the output index and the number of employment in 1966 as a weight for the labor input index, we obtain an index in Group 2,

$$P_{3201}^{1967} = 100 \times \left(\frac{2}{2} \times \frac{2}{12} + \frac{18}{10} \times \frac{10}{12} \right) / \left(\frac{1}{1} \times \frac{1}{3} + \frac{3}{2} \times \frac{2}{3} \right) = 125.$$

Using the value of output in year t as a weight for the labor productivity, we obtain an index in Group 3,

$$P_{3201}^{1967} = 100 \times \left(\frac{2}{1} \times \frac{2}{20} + \frac{18}{3} \times \frac{18}{20} \right) / \left(\frac{2}{1} \times \frac{2}{12} + \frac{10}{2} \times \frac{10}{12} \right) = 124.4.$$

Thus only the index in Group 1 fulfills our ideal criterion.

The selection of a particular index among Group 1 depends heavily on the availability of statistical data. This will be studied in section 4, Chapter III.

COMPUTATION OF THE LABOR PRODUCTIVITY INDEX

For 250 industries at the 5-digit level, the various indexes introduced in chapter II are computed based on the annual surveys for the period 1966 - 1970. Indexes for higher levels are also computed according to the various formulas. Due to the limited space of this paper, only the various indexes at the 1-digit levels (i.e., mining and manufacturing) and the fully aggregated indexes are presented in section 1.

In section 2, trends of the indexes are studied and compared. For a selected index, a study at the 2-digit industrial level is done in section 4. The relationship between labor productivity and capital intensity, and the choice of the lowest level in the construction of the labor productivity index are considered in section 3. The construction of quarterly index, which uses 3rd quarter 1970 productivity as the base level, are discussed in section 5.

1. Computation of Indexes

For the measurement of labor input, the number of persons employed is used for all indexes. In section 2, Chapter II, two different measurements for the labor input are mentioned, namely, "hours" and "numbers of persons employed". In the case of Korean industry, however, the distinction between the two concepts disappears, since days worked are proportional to the number of per-

sons employed[8]. Consequently, the ratio of the number of persons employed at the current year to that of the base year is almost the same as the ratio of the corresponding number of days worked. The following tables provide the identification number of the formulas and the corresponding measurements used.

Table 1. Formulas for indexes in Group 1.

Formula number	Measurement used for		Formula number	Measurement used for	
	output	weight		output	weight
1	O_{ijklm}	O^{o}_{ijklm}	7	V_{ijklm}	V^{o}_{ijklm}
2	"	O^{t}_{ijklm}	8	"	V^{t}_{ijklm}
3	"	V^{o}_{ijklm}	9	O_{ijklm}	L^{o}_{ijklm}
4	"	V^{t}_{ijklm}	10	"	L^{t}_{ijklm}
5	V_{ijklm}	O^{o}_{ijklm}	11	V_{ijklm}	L^{o}_{ijklm}
6	"	O^{t}_{ijklm}	12	"	L^{t}_{ijklm}

[8] The data for hours worked (or man-days worked) are not available in the annual surveys except for the year 1968. For the quarterly indexes, however, the construction of indexes based on both the man-days worked and the number employed is possible (see section 5).

The result of the linear regression of "days worked" in the 6115 firms on the corresponding number employed without the inclusion of the intercept term is ;

estimated coefficient = 26.3 ,
resulted R^2 = 0.9708.

(Based on the monthly survey, Jan. 1972.)

Table 2. Formulas for indexes in Group 2.

Formula number	output index		input index	
	output	weight	input	weight
13	O_{ijklm}	O^{o}_{ijklm}	L_{ijklm}	L^{o}_{ijklm}
14	"	O^{t}_{ijklm}	"	L^{t}_{ijklm}
15	"	V^{o}_{ijklm}	"	L^{o}_{ijklm}
16	"	V^{t}_{ijklm}	"	L^{t}_{ijklm}

Indexes in Group 3 are numbered 17 and 18. Formula number 17 is used as an index based on production per head, and 18 as an index based on value added per head.

Note (on the wage index).

At the 5-digit level, the total wage paid (deflated by the consumer price index) is divided by the number of persons employed. Using the number of persons employed as the weight, an wage index is constructed. Formulas 19 and 20 are the wage indexes of the Laspeyres and the Paasche type, respectively.

A consumer price index to convert the money wage into the real wage is ideal when the purchasing power of laborers is under examination. When the wage is considered as a share received by the worker for his contribution to production, the wage index should be formulated by using each industry's deflator (i.e., wholesale price index). Formulas 21 and 22 are such indexes of the Laspeyres and Paasche type, respectively.

Table 3 Various Indexes for Labor Productivity and Wage (Laspeyres)

Formula number	Industry	1966	1967	1968	1969	1970
1	Mining	100	102.7	101.3	108.0	134.6
	Manufacturing	100	116.8	126.5	154.0	165.6
	Total Industry	100	116.0	125.0	151.3	163.8
3	Mining	100	101.2	101.4	106.7	132.4
	Manufacturing	100	115.2	127.5	154.8	166.9
	Total Industry	100	113.6	124.7	149.6	163.2
5	Mining	100	97.0	98.6	104.1	137.9
	Manufacturing	100	122.6	136.0	168.4	186.5
	Total Industry	100	121.3	133.9	164.7	183.7
7	Mining	100	95.1	98.2	101.2	132.8
	Manufacturing	100	117.6	130.7	164.9	180.8
	Total Industry	100	115.1	127.2	158.0	175.6
9	Mining	100	107.0	103.5	110.2	132.8
	Manufacturing	100	111.0	122.3	146.2	163.5
	Total Industry	100	110.5	120.3	142.4	160.3
11	Mining	100	102.9	103.5	105.8	135.7
	Manufacturing	100	112.2	132.4	158.7	181.8
	Total Industry	100	111.2	129.4	153.1	176.9
13	Mining	100	93.0	88.5	97.0	119.0
	Manufacturing	100	108.4	125.4	151.0	170.1
	Total Industry	100	107.8	124.1	150.4	169.9
15	Mining	100	91.0	88.5	95.4	115.5
	Manufacturing	100	108.6	127.7	153.5	172.0
	Total Industry	100	106.7	123.9	148.5	167.1
17	Mining	100	93.0	88.5	97.0	119.0
	Manufacturing	100	108.3	125.4	151.0	170.1
	Total Industry	100	107.8	124.1	150.4	170.0
18	Mining	100	85.8	85.0	91.0	117.4
	Manufacturing	100	109.4	131.0	163.5	185.9
	Total Industry	100	107.0	126.5	157.4	180.0
19	Mining	100	112.5	107.0	132.9	134.1
	Manufacturing	100	115.7	126.7	142.6	151.1
	Total Industry	100	115.4	124.6	141.5	149.3
21	Mining	100	108.4	95.1	120.0	138.6
	Manufacturing	100	119.1	137.9	170.2	197.7
	Total Industry	100	117.9	133.4	164.9	191.4

Base year on 1966

Table 4 Various Indexes for Labor Productivity and Wage (Paasche)

Formula number	Industry	1966	1967	1968	1969	1970
2	Mining	100	104.7	101.5	111.[illegible]	147.9
	Manufacturing	100	126.4	150.1	187.9	220.0
	Total Industry	100	125.4	148.3	185.7	217.7
4	Mining	100	104.3	102.6	111.6	150.0
	Manufacturing	100	126.6	150.0	188.1	221.3
	Total Industry	100	124.8	147.8	184.4	217.4
6	Mining	100	100.2	98.8	111.1	164.8
	Manufacturing	100	132.0	156.7	200.0	243.3
	Total Industry	100	130.5	154.6	197.4	241.3
8	Mining	100	100.1	100.7	112.1	170.0
	Manufacturing	100	138.0	159.9	204.9	251.2
	Total Industry	100	134.9	156.0	200.4	246.8
10	Mining	100	95.3	89.1	96.0	112.1
	Manufacturing	100	109.4	123.6	146.2	165.9
	Total Industry	100	108.0	120.3	142.1	161.5
12	Mining	100	92.2	88.4	91.5	113.6
	Manufacturing	100	110.0	133.2	158.1	184.1
	Total Industry	100	108.2	128.9	152.7	178.4
14	Mining	100	67.4	56.9	75.6	90.2
	Manufacturing	100	136.1	156.4	171.8	212.2
	Total Industry	100	131.8	152.1	172.3	211.2
16	Mining	100	68.0	57.4	74.1	92.1
	Manufacturing	100	130.3	166.4	178.2	217.2
	Total Industry	100	124.4	158.6	176.2	212.8
20	Mining	100	102.1	94.7	118.9	115.5
	Manufacturing	100	115.8	129.8	145.3	157.2
	Total Industry	100	114.5	126.4	143.1	153.8
22	Mining	100	101.2	88.3	108.6	117.5
	Manufacturing	100	118.9	137.7	170.2	199.3
	Total Industry	100	117.1	133.0	165.2	192.7

Base year on 1966

2. Comparisons and Characteristics of Indexes

Although these indexes are accurate for the period to which they refer, extrapolations based on trends during this short period may not be completely reliable. The indexes only for the fully aggregated level are presented and analyzed in this section. Since the portion which the manufacturing sector occupies is large, the analysis and conclusions for the index of the manufacturing sector are similar to those reached for the total index.

For two indexes I_1 and I_2, the symbol $I_1 \approx I_2$ is used to denote that the trend (or growth rate) of I_1 is almost identical to the of I_2 over time, while $I_1 \lesssim I_2$ is used to denote that the trend of I_1 is lower than that of I_2.

From the table 3 and 4 the followings are observed:

i) For the indexes in Group 1, the choice of weights, whether it is the value of production or value added, does not affect the trend of the index as long as the measurements of output are consistent. That is, $1 \approx 3$, $2 \approx 4$, $5 \approx 7$ and $6 \approx 8$. This follows from the fact that in each industry the value added is nearly proportional to the value of production with respect to time and the dispersion of the factors of proportionality is narrow[9]. Letting P_t^i be the total index

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[9] For each industry i ($i=1,2,\ldots,250$) the value added is linearly regressed without a constant term on the value of production (i.e., $V_i^t = a_i O_i^t + e_i^t$, $t=0,\ldots,4$) and the followings are observed.

of formula i in year t, t=0,1,2,3,4[10] and

$R^i_t = (P^i_{t-1} - P^i_t) / P^i_t$, t=1,2,3,4 and i=1,2, ... , 8,

the following results are obtained ; for i=1,2,5,6,

$$\frac{1}{4}\left|\sum_{t=1}^{4} (R^i_t - R^{i+2}_t)\right| \in (0,\ 0.01),$$

$$\frac{1}{4}\sum_{t=1}^{4} \left|R^i_t - R^{i+2}_t\right| \in (0.01,\ 0.02).$$

In words, the dirrerences in the annual growth rates of the two indexes are quite small. Also it is observed that the average growth rate of the two is negligible.

ii) When the weights used are the same (the value of production or the value added), the Paasche type total index is much higher than the corresponding Laspeyres type. That is, $1 \lesssim 2$, $3 \lesssim 4$, $5 \lesssim 6$, $7 \lesssim 8$, $13 \lesssim 14$ and $15 \lesssim 16$. This difference arises from the fact that the rapid expansion of modern industries results not only in output per laborer being relatively higher (i.e., the individual labor productivity index being higher) but results also in the changed

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i)

Range of R^2	$0.99 < R^2 \leq 1$	$0.98 < R^2 \leq 0.99$	$0.87 < R^2 \leq 0.98$
# of industry	175	44	31

ii) $\bar{a}$ = 0.419 and the sample variance = 0.0147.

10 Here t=0, ... , 4 is used for that t=1966, ... , 1970.

volume of current output in the modern industries having a relatively greater impact on the total index due to the large weights received by these industries.

iii) It is seen that 9 ≈ 10 and 11 ≈ 12. That is, when the number of persons employed is used for a weight, the trends shown by the Laspeyres or Paasche type indexes are almost identical. Among the 3-digit level industries, the structures of labor in the industries, 311, 321, 381 and 384 (which are relatively large industries) are shown in the following table.

Table 5 Changes in the number of persons employed over time

Industry	% of number employed to total in 1966	% of number employed to total in 1970
311	6.56	6.65
321	22.01	22.14
381	4.03	3.75
384	4.22	4.61
Sub total	36.82	37.15

3. Other Influencing Factors

3.1. Labor productivity and capital intensity.

The data on total tangible fixed assets are only available for the years 1966 and 1968. It seems, however, that capital intensity

(K/L) is increasing in most industries as time passes. It is not possible to pursue a study of the relation between the trend of average labor productivity and changes in capital intensity at this time due to the lack of time series data on the capital stock. There were some efforts to estimate the successive annual capital stock, but no satisfactory result came out[11]. This lack of data also presently prevents the study of the level of total factor productivity, in which total factor input is measured as a weighted sum of the labor and capital involved to produce the corresponding output. Fabricant[12] demonstrates that the annual growth rate of the average labor productivity in the USA (2.4%) since 1889 has been higher than that of total factor productivity. In the case of Korea, the growth rate of average labor productivity also seems higher than that of total factor productivity index. Moreover, the latter seems higher than the average capital productivity index. The same is true for the corresponding rates of growth. (See Appendix II).

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[11] A estimating formula suggested by Dr. Chuk Kyo Kim is $K_{t+1} = K_t + I_{t+1} - D_{t+1}$, where K denotes the capital stock, I the investment and D disposal. This formula would be ideal if the annual data were collected from "fixed establishments", but our series does not account for the birth and death of firm

[12] See Fabricant [1, PP. 13-14].

For the year 1966 and 1968, however, the following results are obtained:

i) 1966

At the 3-digit industry level, the following table of ranking (among 32 industries) is obtained.

Table 6 Ranks of capital intensities and the corresponding values of output per head in 1966.

In thousand won

Rank of K/L	K/L	O/L	Industry code
1	2806	9876	353
2	887	1136	351
3	791	2439	314
⋮	⋮	⋮	⋮
30	143	240	361
31	137	411	324
32	104	324	390

The rank correlation coefficient of (K/L, O/L) for 250 5-digit industries is 0.9169.

i) 1968

The table corresponding to table 6 for the year 1968 is

Table 7 Ranks of capital intensities and the corresponding values of output per head in 1968.

In thousand won

Rank of K/L	K/L	O/L	Industry code
1	3622	12795	353
2	2364	2666	351
3	1623	770	369
⋮	⋮	⋮	⋮
30	163	509	324
31	132	4	390
32	109	158	361

The rank correlation coefficient of (K/L, O/L) is 0.9288.

iii) The rank correlation between the rate of change in K/L (1966 to 1968) and the rate of change in the labor productivity index (using formula 3) is 0.9227.

It is observed from i), ii) and iii) that in each period influence of K/L on O/L is substantial and that the labor productivity index as a reflection of the relative change in average labor productivity between two points in time is highly correlated with the relative change in the capital intensities for the corresponding time period. Fabricant states that the change in output per labor input is caused by any combination of changes in efficiency, labor

quality, and capital intensity[13]. Our main concern is, as mentioned earlier, the computation of an ideal average labor productivity index, and any effort forwards the decomposition of the change in labor productivity index over time is not pursued at present.

3.2. Choice of Level.

From which level of the industrial classification should the labor productivity index be computed? At the commodity level?, at the 5-digit level? , ... , or at the fully aggregated level? The choice of the lowest level depends mainly on the available statistical data. The 18 total indexes in table 3 and 4 are those computed from the 5-digit level. In the cases of formulas 13, 17 and 18, the choice of the lowest level does not affect to the total index. For the rest, the changes in the growth rates shown by the total indexes caused by the different choices of level are computed as follows :

Let $P^i_{k,t}$ be the total index of the formula i, i=1,2, ... , 12,14,15,16 computed from the k-digit level, k=3,4,5, at year t=0,1,2,3,4[14], and

$$R^i_{k\,t} = (P^i_{k,t} - P^i_{k,t-1}) \;/\; P^i_{k,t-1} \;,$$

$$R^i_{k} = (P^i_{k,t} \;/\; P^i_{k,o})^{\frac{1}{4}} - 1.$$

---

[13] See Fabricant [1, PP. 11].

[14] Because of the limited space $P^i_{3,t}$ and $P^i_{4,t}$ are not presented.

The following table shows the difference in the growth rate of the total index under different choices of the lowest level.

Table 8. Comparison of Growth rates under different choices of levels of aggregation.

Formula number (i)	$\lvert R_5^i - R_4^i \rvert$	$\lvert R_4^i - R_3^i \rvert$	$\frac{1}{4}\sum_{t=1}^{4}\lvert R_{5t}^i - R_{4t}^i \rvert$	$\frac{1}{4}\sum_{t=1}^{4}\lvert R_{4t}^i - R_{3t}^i \rvert$
1	0.0016	0.0029	0.010	0.008
2	0.0247	0.0259	0.023	0.025
3	0.0017	0.0041	0.010	0.013
4	0.0243	0.0221	0.025	0.023
5	0.0014	0.0038	0.018	0.008
6	0.0286	0.0329	0.030	0.033
7	0.0039	0.0032	0.008	0.010
8	0.0307	0.0299	0.030	0.030
9	0.0002	0.0030	0.010	0.008
10	0.0049	0.0031	0.005	0.005
11	0.0008	0.0031	0.015	0.010
12	0.0002	0.0077	0.010	0.005
14	0.0432	0.0700	0.158	0.090
15	0.0002	0.0010	0.003	0.005
16	0.0448	0.0723	0.135	0.115

It is seen from Table 8 that the influence due to the choice among different levels of aggregation seems negligible in the case of the Laspeyres type, while substantial in the case of the Paasche type.

4. A selected index.

As a class of ideal indexes, those in Group 1 (i.e., formula number 1-12) are recommended in section 4, Chapter II. In the case of the Korean economy (1966 - 1970), it is seen that the indexes based on the value of production and the value added for the measurement of the output are almost identical as long as the weights used are the same (section 2). By taking the index of formula 3 for the selected index, it is possible to connect the annual index with the quarterly index because the volume of production, not value added, is surveyed monthly. Also formula 3 is a Laspeyres index which we prefer to formula 4, a Paasche index, because of the previously mentioned relative stability of the former.

Rewriting the formula 3,

$$P_{ijklm} = (O^{t}_{ijklm} / L^{t}_{ijklm}) / (O^{o}_{ijklm} / L^{o}_{ijklm}) ,$$

$$P_{ijkl} = \sum_{m} P_{ijklm} \frac{V^{o}_{ijklm}}{V^{o}_{ijkl+}} ,$$

$$\vdots$$

$$P_i = \sum_j P_{ij} \frac{V^o_{ij+++}}{V^o_{i++++}} ,$$

$$P = \sum_i P_i \frac{V^o_{i++++}}{V^o_{+++++}} .$$

The trend and characteristics of this index are studied in this section. Also, the relationship between the labor productivity index and the wage index is studied.

4.1. Choice of Base year.

Generally the choice of the base year on which an index is computed influences trends indicated by the index. As the following table shows, the total index of formula 3 is not affected much by the choice of the base year.

Table 9. Comparison of trends under different choices of base year for the selected index.

Total index	66	67	68	69	70
Base year on 70	60.5	71.6	75.9	91.3	100.0
Base year on 66[15]	61.3	69.6	76.4	91.7	100.0

[15] The numbers are standardized so that the index of 70 is 100.0.

4.2. Wage index.(Based on '70)

The wage index computed on the basis of consumer price index is denoted by "wage index (I)" while "wage index (II)" denotes that based on the appropriate industrial wholesale price index. The fact that the total wage index (I) $\lesssim$ wage index (II) follows from the fact that the consumer price index, on the whole, grows faster than the wholesale price index. The management of an industry would insist that the wage index (II) is ideal, while the labour union would take the wage index (I) as an ideal one.

4.3. Computation of Index.

The selected index is computed based on 1970, since most Korean economic indexes and the quarterly labour productivity index are computed based on 1970. The computation of the selected index at the 2-digit industrial level and up and wage indexes are presented in table 10.

Table 10 The Value of Labor Productivity Index Using Formula 3

Ind. code	Description	Type of Index	Index					Relative Growth				Annual Average Growth
			66	67	68	69	70	66-67	67-68	68-69	69-70	
	Total	L.P	60.5	71.6	75.9	91.3	100.0	1.18	1.06	1.20	1.10	1.13
		W(I)*	72.9	80.1	85.7	97.1	100.0	1.10	1.07	1.13	1.03	1.08
		W(II)	63.2	67.2	73.4	89.6	100.0	1.06	1.09	1.22	1.12	1.12
2	Mining and Quarrying		81.7	74.7	71.0	81.0	100.0	0.91	0.95	1.14	1.23	1.05
		"	112.3	92.9	81.6	105.9	100.0	0.83	0.88	1.30	0.94	0.97
			149.5	95.1	80.3	98.9	100.0	0.64	0.84	1.23	1.01	0.90
21	Coal Mining		76.8	80.6	79.8	80.9	100.0	1.05	0.99	1.01	1.24	1.07
		"	70.6	84.4	75.3	96.0	100.0	1.20	0.89	1.27	1.04	1.09
			69.3	76.1	68.9	86.0	100.0	1.10	0.91	1.25	1.16	1.10
23	Metal Ore Mining		56.9	55.2	49.0	71.5	100.0	0.97	0.89	1.46	1.40	1.15
		"	80.6	95.7	90.8	104.0	100.0	1.19	0.95	1.15	0.96	1.06
			59.9	80.0	67.1	86.4	100.0	1.34	0.84	1.29	1.16	1.14
29	Other Non-metallic Mineral Mining		155.5	99.2	91.9	103.2	100.0	0.64	0.93	1.12	0.97	0.90
		"	171.8	101.2	84.8	117.7	100.0	0.59	0.84	1.39	0.85	0.87
			275.4	122.3	98.3	118.4	100.0	0.44	0.80	1.20	0.84	0.78

* Here L.P stands for Labor Productivity, W(I) for Wage(I), and W(II) for Wage(II).

Table 10 (Cont'd)

Ind. code	Description	Type of Index	Index					Relative Growth				Annual Average Growth
			66	67	68	69	70	66-67	67-68	68-69	69-70	
3	Manufacturing	L.P	59.3	71.4	76.2	91.9	100.0	1.20	1.07	1.21	1.09	1.14
		W(I)	69.4	78.9	86.1	96.3	100.0	1.14	1.09	1.12	1.04	1.10
		W(II)	55.5	64.7	72.8	88.8	100.0	1.17	1.13	1.22	1.13	1.16
31	Manufacture of Food, Beverages and Tobacco	L.P	59.0	73.5	82.1	91.6	100.0	1.25	1.12	1.12	1.09	1.14
		W(I)	66.2	74.9	82.5	94.2	100.0	1.13	1.10	1.14	1.06	1.11
		W(II)	56.8	64.0	71.9	86.1	100.0	1.13	1.12	1.20	1.16	1.15
32	Textile, Wearing Apparel and Leather Industries	L.P	64.9	72.1	71.3	82.9	100.0	1.11	0.99	1.16	1.21	1.11
		W(I)	66.3	83.3	86.8	97.0	100.0	1.26	1.04	1.12	1.03	1.11
		W(II)	50.7	65.1	69.3	85.6	100.0	1.28	1.06	1.24	1.17	1.18
33	Manufacture of Wood and Wood Products, Including Furniture	L.P	84.6	95.3	95.1	102.1	100.0	1.13	1.00	1.07	0.98	1.04
		W(I)	78.9	93.2	88.1	104.4	100.0	1.18	0.95	1.19	0.96	1.06
		W(II)	63.7	79.7	81.5	106.9	100.0	1.25	1.02	1.31	0.94	1.12
34	Manufacture of Paper and Paper Products, Printing and Publishing	L.P	67.4	67.6	77.0	89.4	100.0	1.00	1.14	1.16	1.12	1.10
		W(I)	67.2	75.6	88.5	97.0	100.0	1.13	1.17	1.10	1.03	1.10
		W(II)	48.3	58.7	72.2	86.6	100.0	1.22	1.23	1.20	1.15	1.19

Table 10 (Cont'd)

Ind. code	Description	Type of Index	Index					Relative Growth				Annual Average Growth
			66	67	68	69	70	66-67	67-68	68-69	69-70	
35	Manufacture of Chemicals and Chemical, Petroleum Coal, Rubber and Prastic Products	L.P	44.5	66.4	67.9	90.2	100.0	1.49	1.02	1.33	1.11	1.22
		W(I)	74.5	77.3	95.7	98.1	100.0	1.04	1.24	1.03	1.02	1.08
		W(II)	53.1	58.1	78.8	88.5	100.0	1.09	1.36	1.12	1.13	1.17
36	Manufacture of Non-metallic Mineral Products, except Products of Petroleum and Coal		75.0	67.1	62.7	88.7	100.0	0.89	0.93	1.41	1.13	1.07
		"	93.0	75.9	76.6	101.8	100.0	0.82	1.01	1.33	0.98	1.02
			93.1	70.9	68.9	96.3	100.0	0.76	0.97	1.40	1.04	1.02
37	Basic Metal Industries		74.4	80.5	74.4	113.0	100.0	1.08	0.92	1.52	0.89	1.08
		"	81.0	79.0	82.8	103.9	100.0	0.98	1.05	1.25	0.96	1.06
			69.6	72.8	81.4	109.8	100.0	1.05	1.12	1.35	0.91	1.09
38	Manufacture of Fabricated Metal Products, Machinery and Equipment		57.6	69.2	87.1	104.3	100.0	1.20	1.26	1.20	0.96	1.15
		"	67.1	75.7	89.3	95.2	100.0	1.13	1.18	1.07	1.05	1.11
			54.4	64.0	76.2	89.3	100.0	1.18	1.19	1.17	1.12	1.16
39	Other Manufacturing Industries		71.0	81.5	86.0	76.9	100.0	1.15	1.06	0.89	1.30	1.09
		"	51.0	71.1	68.7	78.1	100.0	1.39	0.97	1.14	1.28	1.18
			39.6	60.8	62.7	75.2	100.0	1.54	1.03	1.20	1.33	1.26

4.4. Analysis of Trends at Various Industrial Levels.

As mentioned in section 4, Chapter II, the cause of a change in the growth rate at a certain time point is easily identified from the lower level in the case of using the selected index. This is demonstrated briefly in this sub-section.

Let P^t_{ijklm}, ... , P^t_i, P^t be the labor productivity index at the level of 5-digit, ... , 1-digit, total for the year t.

Definition.

Let the relative growth[16] of the labor productivity index at the year t to year t-1 be

$$R^t_{ijklm} = P^t_{ijklm} / P^{t-1}_{ijklm} ,$$

$$\vdots$$

$$R^t_i = P^t_i / P^{t-1}_i ,$$

$$R^t = P^t / P^{t-1} , \quad t=1967, \ldots , [illegible]$$

Let the average annual growth[17] be

---

[16] See the second last column in table 10 (e.g., R^{1967}_{21} 80.6/76.8 = 1.05).

[17] See the last column in table 10 (e.g., S = (100/[illegible] 1.13).

$$S_{ijklm} = (P^{1970}_{ijklm} \;/\; P^{1966}_{ijklm})^{\frac{1}{4}} ,$$

$$\vdots$$

$$S_{i} = (P^{1970}_{i} \;/\; P^{1966}_{i})^{\frac{1}{4}} ,$$

$$S = (P^{1970} \;/\; P^{1966})^{\frac{1}{4}} .$$

As a consequence of the formulation of the index, P^{t}_{ijkl} is a function of $\left\{P^{t}_{ijklm} , W_{ijklm}\right\}_{m=1}^{M_1}$, ... , and P^{t} is a function of $\left\{P^{t}_{i} , W_{i++++}\right\}_{i=1}^{I}$. Similarly, R^{t}_{ijkl} depends substantially on $\left\{R^{t}_{ijklm} , W_{ijklm}\right\}_{m=1}^{M_1}$, ... , and R^{t} on $\left\{R^{t}_{i} , W_{i++++}\right\}_{i=1}^{I}$

<u>Symbol</u>.

The symbol "A $\Longrightarrow$ B" is used to denote that statement A is a influencing main factor on statement B.

It is seen from table 10 that $R^{1967}_{3} = 1.20$, $R^{1968}_{3} = 1.07$, $R^{1969}_{3} = 1.21$, $R^{1970}_{3} = 1.09$ and $S_3 = 1.14$. If $R^{t}_{3} > S_3$ for some t then the major influencing factors on making R^{t}_{3} high are investigated. If $R^{t}_{3} < S_3$ for some t then the converse factors are investigated. To do this the following table of the weights used is needed.

Table 11. Weights[18] taken by 2-digit level industries with respect to the whole manufacturing sector.

Industry code	Weight
3	1.000
31	0.225
32	0.176
33	0.034
34	0.054
35	0.253
36	0.055
37	0.037
38	0.139
39	0.027

i) The tobacco industry (31400) had increased its output by 20 % in 1967 relative to that in 1966, decreasing the corresponding labor forces by 12 %, so that

$$R^{1967}_{31400} = 1.38 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(i-1)},$$

$$\text{(i-1) and } (W_{31400} / W_{31+++}) = 0.391 \Longrightarrow R^{1967}_{31} = 1.25 \ \ldots \text{(i-2)}.$$

ii) The industry for the manufacture of synthetic resin plastic materials (35131) had increased its output 2.3 times in 1967

[18] Note that the weight used is the output in 1970.

as a result of the large increase in capital investment relative to 1966, keeping the corresponding labor forces at the same level, from which it follows that

$$R^{1967}_{35131} = 2.93 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(ii-1)},$$

$$\text{(ii-1) and } (W_{35131} / W_{351++}) = 0.42 \Longrightarrow R^{1967}_{351} = 1.55 \quad .. \text{(ii-2)}.$$

The industry concerned with the extracting and blending gasoline and residual fuels (35301) had increased its output by 1.9 times in 1967 relative to that in 1966 due to a large increase in capital investment combined with a smaller labor force, so that

$$R^{1967}_{35301} = R^{1967}_{353} = 2.11 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(ii-3)},$$

$$\text{(ii-2), (ii-3), } (W_{351++} / W_{35+++}) = 0.37 \text{ and } (W_{353++} / W_{35+++}) = 0.19 \Longrightarrow R^{1967}_{35} = 1.49 \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(ii-4)},$$

$$\text{(i-2) and (ii-4)} \overset{19}{\Longrightarrow} R^{1967}_{3} = 1.20 \ .$$

iii) The knitted outerwear industry(32134) had decreased its output by 19 % in 1968 relative to that in 1967, while the corresponding labor force increased by 49 %. Moreover, as the following table shows, many industries in the same group (32) had the lower relative growths.

---

[19] See table 11 for the weights of industries, 31 and 35.

Table 12. Growth rates in '68 (with respect to '67) and weights of the large 5-digit industries in Textile, wearing apparel and leather industries.

Industry code	B^{1968}_{ijklm}	Weight
32		1.00
32134	0.54	0.11
32152	0.95	0.03
32161	0.93	0.06
32164	0.92	0.07
32173	0.84	0.08

Table 12 $\Longrightarrow B^{1968}_{321} = 0.96 \Longrightarrow B^{1968}_{32} = 0.99$ ..... (iii-1).

iv) A major firm in the industry of extracting and blending gasoline and residual fuels (35301) had been established in 1968 and had employed large numbers of laborers before operations were commenced (i.e., without producing any output). As a consequence the output of the industry (35301) increased only slightly relative to that in 1967, while the number of persons employed went up by 89 %. It seems that in 1969 this new born firm began production, and the following results are observed :

$R^{1968}_{35301} = 0.615$ ..... (iv-1).

$R^{1969}_{35301} = 1.716$ ..... (iv-2),

$W_{35301} / W_{35+++} = 0.27$ ..... (iv-3),

(iv-1) and (iv-3) $\Longrightarrow R^{1968}_{35} = 1.023$ ..... (iv-4),

(iv-2) and (iv-3) $\Longrightarrow R^{1969}_{35} = 1.328$ ..... (iv-5),

(iv-4) and (iii-1) $\Longrightarrow R^{1968}_{3} = 1.067$.

v) The large amount of capital investment in the cement industry (36921) resulted in a 38 % increase in output in 1969 relative to that in 1968 with a smaller labor force used, so that

$R^{1969}_{36921} = 1.618$ .... (v-1),

(v-1) $\Longrightarrow R^{1969}_{36} = 1.415$ (note that $W_{36921} / W_{36+++} = 0.53$) ..... (v-2),

(v-1) and (iv-5) $\Longrightarrow R^{1969}_{3} = 1.206$.

vi) A large firm in the motor vehicles industry (38431) had been established in 1970 without contributing to the productions of motor vehicles. As a consequence, the relative increase in output (7 %) in 1970 with respect to 1969 is much lower than the corresponding relative increase of the labor force (52 %), so that

$$R^{1970}_{38431} = 0.702 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(vi-1)},$$

$$\text{(vi-1)} \Longrightarrow R^{1970}_{38} = 0.959 \Longrightarrow R^{1970}_{3} = 1.088.$$

vii) Due to the large annual variation of output levels in the salt mining industry, the trend of the index for the mining and quarrying industry is not upward year to year. The weight given to the manufacturing sector (95 %) is substantially larger than that given to the mining industry, so that the trend of the total index is almost identical to that of the manufacturing.

4.5. Comparison with the Wage Index.

In this subsection the relationship between the labor productivity index and the wage index is briefly studied. In the case of the manufacturing sector, as shown in Table 13 average annual growth rate of the wage index is 2 % higher than that of the labor productivity index when the wage is considered as a share receiving compensation for the contribution of the laborer to the production of a given output, while it is 4 % lower when the wage is considered as the amount of purchasing power given to the laborer[20]. The following table provides a good illustration for the 2-digit industries in the manufacturing sector.

---

[20] For the two different concepts in the wage index, see Note on PP. 19, and section 4.2 in this chapter.

Table 13. Comparison of the average annual growth rate of labor productivity index (L.P.I.) and wage indexes for the period 1966-1970.

Industry code	Average annual Growth Rate (in %)			% in labor forces
	L.P.I.	W(I)	W(II)	
3	14	10	16	100.0
31	14	11	15	13.6
32	11	11	18	31.1
33	4	6	12	5.3
34	10	10	19	5.7
35	22	8	17	11.7
36	7	2	2	5.9
37	8	6	9	3.7
38	15	11	16	17.4
39	9	18	26	5.6

5. Quarterly Index.

As mentioned in section1, Chapter I, there is not an exact correspondence in the figures between output and labor input in the monthly suvey data. However, it must be remembered that the proportion of the output of the firms surveyed made up of commodities not on the short list is negligible. Also if these small proportional figures do not change much over time, the index constructed from this survey will not be affected.

For each firm surveyed, there are data of the physical volume (${}_{f}Q^{t}_{ijklmn}$) or the monetary value (${}_{f}\hat{O}^{t}_{ijklmn}$) for each commodity produced by the firm, the number of persons employed (${}_{f}L^{t}_{ijklm}$), the man-days worked (${}_{f}M^{t}_{ijklm}$) and the wage paid (${}_{f}S^{t}_{ijklm}$)[21]. Here t denotes the quarter beginning with $t=0$ for 3rd quarter 1970. The value of variables for a quarter is the simple average of values for the corresponding months.

For commodities surveyed in terms of physical volume(case 1), an appropriate unit price (U_{ijklmn}) is derived from the annual survey of 1970, while for commodities surveyed in terms of monetary value (case 2), an appropriate deflator (D^{t}_{ijklmn}) is derived from the wholesale price index, so that

$$
{}_{f}O^{t}_{ijklmn} = \begin{cases} {}_{f}Q^{t}_{ijklmn} \; U_{ijklmn} & \text{for the case 1,} \\ {}_{f}\hat{O}^{t}_{ijklmn} \; D^{t}_{ijklmn} & \text{for the case 2.} \end{cases}
$$

Now in order to simplify the notation, we will denote each firm's output of commodities on the short list(aggregated at the 5-digit level) by

$$
{}_{f}O^{t}_{ijklm} = {}_{f}O^{t}_{ijklm+} = \sum_{n} {}_{f}O^{t}_{ijklmn} ,
$$

---

[21] The left subscript, f, denotes the number assigned to each individual firm. The sixth right subscript, n, denotes the number assigned to individual commodities. $\hat{O}$ denotes the current (undeflated) value of production.

and total output of commodities on the short list (also at the 5-digit level) by

$$O^t_{ijklm} = O^t_{+ijklm} = \sum_f {}_fO^t_{ijklm} .$$

Also,

$$L^t_{ijklm} = L^t_{+ijklm} = \sum_f {}_fL^t_{ijklm} ,$$

$$M^t_{ijklm} = M^t_{+ijklm} = \sum_f {}_fM^t_{ijklm} ,$$

$$S^t_{ijklm} = S^t_{+ijklm} = \sum_f {}_fS^t_{ijklm} .$$

The weights $\left\{W_{ijklm}\right\}$ used for the aggregation of the lower level indexes to the higher are derived from the value added data of 1970 annual survey.

<u>Definition.</u>

The labor productivity indexes at various industrial levels are constructed as follows :

$$P^t_{ijklm} = \frac{O^t_{ijklm} \;/\; L^t_{ijklm}}{O^o_{ijklm} \;/\; L^o_{ijklm}} ,$$

$$P^t_{ijkl} = \sum_m P^t_{ijklm} \; W_{ijklm} \;/\; W_{ijkl+}$$

$$\vdots$$

$$P^t = \sum_i P^t_i \; W_{i+++++} \;/\; W_{++++++} .$$

By replacing the number of employees with the man-days worke for the measurement of the labor input, a corresponding index can be constructed. The difference in labor productivity indexes using "hours" and "numbers" for the measurement of labor input was scussed in section 2.2, Chapter II, and section 1, this chapter.

Note (on quarterly wage index).

As in the annual wage indexes, the quarterly wage index (I), at the level of 5-digit industries, is the ratio of wages paid (deflated by the consumer price index) per person in the current riod to that of the base period, while the wage index (II) is the same except that the wage paid is deflated by the appropriate who lesale price index. Both indexes are then aggregated to higher l vels by using the number of persons employed as their weights.

We will be in a position to present a quarterly labor produc vity index and wage indexes, extending our annual series of 1966 1970, by the middle of July, 1972.

APPENDIX I

Influencing Factors on the Change of Index

Under the Cobb-Douglas production function,

$$O_t = c \exp(rt) K_t^a L_t^b ,$$

the index of average labor productivity at the period t with respect to the base period s is

$$P = \frac{O_t / L_t}{O_s / L_s} = (K_t / K_s)^a (L_t / L_s)^{b-1} \exp(r(t-s)) ,$$

applying the chain rule, we obtain

$$dp = P \left\{ a \, dlog(K_t / K_s) + (b-1) dlog(L_t / L_s) \right\} .$$

Remarks.

Under most production functions, it is possible to express the change in the average labor productivity index as a function of the relative changes in labor and capital.

APPENDIX II

Comparison of Labor and Capital Productivity Index

For 250 5-digit industries, let Y^t_{ijklm} be the ratio of the capital intensity of t year to that of 1966, i.e.,

$$Y^t_{ijklm} = (K^t_{ijklm} / L^t_{ijklm}) / (K^o_{ijklm} / L^o_{ijklm})$$

Because of the limitations in data availability, Y^t_{ijklm} are computed explicitly only for $t = 1968$ and was found to be greater than 1 for about 75 % of the industries observed. Most big sized industries are contained in those 75 %. There is a strong indication that this has been true for all following years.

Let

$$P^t_{ijklm} = \frac{O^t_{ijklm} / L^t_{ijklm}}{O^o_{ijklm} / L^o_{ijklm}}$$

$$F^t_{ijklm} = \frac{O^t_{ijklm} / (W_1 L^t_{ijklm} + W_2 K^t_{ijklm})}{O^o_{ijklm} / (W_1 L^o_{ijklm} + W_2 L^o_{ijklm})}$$

where W_1 and W_2 are some positive weights, and let

$$G^t_{ijklm} = \frac{O^t_{ijklm} / K^t_{ijklm}}{O^o_{ijklm} / K^o_{ijklm}}$$

It can be straightforwardly shown that

$$F^{t}_{ijklm} = P^{t}_{ijklm} \left[1 - \frac{W_2 \, (R^{t}_{ijklm} - 1)}{W_2 \, R_{ijklm} + W_1 \, L^{o}_{ijklm} / K^{o}_{ijklm}} \right] \quad \ldots\ldots\ldots (1)$$

and that

$$F^{t}_{ijklm} = G^{t}_{ijklm} \left[1 + \frac{W_1 \, (R^{t}_{ijklm} - 1)}{W_1 \, R^{t}_{ijklm} + W_2 \, K^{o}_{ijklm} / L^{o}_{ijklm}} \right] \quad \ldots\ldots\ldots (2)$$

From the facts mentioned above and equations (1) and (2), it may be seen that the relation $P^{t}_{ijklm} < F^{t}_{ijklm} < G^{t}_{ijklm}$ holds in most industries.

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Preliminary
Not to be quoted

A MACRO-ECONOMIC MODEL OF KOREA FOR THE OVERALL RESOURCES BUDGET

Yung Bong Kim

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PREFACE

This paper is one in the series of continuing KDI research works which is designed to aid in the formulation of sound public policies and to promote public understanding of issues of the Korean economy.

This paper is part of our on-going research which deals with the structural relationships of the Korean economy and their projections by an econometric model. The ultimate objective of the model is to evaluate the effects of major economic policies and to define the range of policy implications for the economic development programs. It is hoped that this paper will help to stimulate the exchange of useful knowledge for the future improvement.

The interpretations and conclusions in this paper are those of the author or authors and do not represent the views of the Korea Development Institute. Finally, I would like to extend my appreciation to those within and outside of this Institute who have participated in these endeavours.

Mahn Je Kim
President

A MACRO-ECONOMIC MODEL OF KOREA FOR THE OVERALL RESOURCES BUDGET*

by

Yung Bong Kim

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* This paper is part of a KDI project on "A Balance of Payments and Import of Foreign Capital Projection Model," and to be presented at KDI symposium on July 5-6, 1972. The author is grateful to Mahn Je Kim, and Senior Fellows at KDI for helpful comments.

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I. INTRODUCTION

Since 1967, when the revised set of national income data were released by the Bank of Korea, a number of domestic and foreign economists have involved themselves in building macro-economic models for Korea. [1, 6, 8, and 10] This work was largely financed and developed for the purpose of finding interrelations among economic variables which could be used for the formulation of economic development plans.

It is generally agreed, however, that the major contribution of this work can be found in the advancement of economic science in Korea rather than in the policy implementation. Efforts devoted to the development of scientific economic models have not fully paid off in practical planning due to data insufficiency and frequent structural change of the economy. Although estimates on macro-economic variables such as overall rates of growth of output, investment, savings, exports and imports were critical in designing and executing development programs, lack of confidence in the statistical base and in their performance has limited application of aggregate models to economic planning. Except for some overall resource budgeting, guesswork and estimates obtained by sectoral models were more frequently used to derive macro-estimates.

As we expect that a greater reliance would be placed upon the estimates of an aggregate model in future planning work, it becomes increasingly necessary to develop a macro-economic model which should reveal the long-term structural trend of the economy. It is still early to develop such a model since data is still incomplete and the learning

period to catch the consistent behaviour of the economy is too short. This present paper, therefore, intends to be another model building exercise, hoping that some of its findings may be of use for the construction of improved macro-economic models.

This paper attempts to put together more available information, data and techniques, and to apply some macro-economic theories to practical model building in Korea. It is a main objective of this paper to do annual projections, which, if possible, reflect the apparent recent down-turning trend of the economy.

The model assumes two separate systems in the determination of income; it forecasts output level solely determined by production processes, and GNP on the demand side is determined by estimating the level of investment, consumption and imports, respectively. The "ex ante" gap between them should be interpreted as an inflationary or deflationary gap which indicates precautionary financial and fiscal measures to be taken. For this, powerful financial intermediation is allowed to influence both the level of GNP on demand and production sides. Financial variables function as an input in production, and, with taxes, determine the level of investment and, in turn, imports.

The inclusion of such powerful financial intermediation, in which the Government is a main agent, increases the practical value of the model for planning purposes, unless we are bothered by possible arguments against its use from a theoretical point of view. Financial variable necessarily enters the system as a policy variable for attaining overall equilibrium of the economy, unless we propose a closed system, in which there is little interdependence between monetary and real sectors except

that monetary policy could affect the attainment of short-run equilibrium of the price level. The intervention of financial variable in the production function, meanwhile, erases a dichotomy between the supply and demand sides of the system, since monetary policy affects the level of investment and import.

A fuller description of the structural equations, and their data, estimation and theoretical background are presented in Section II of this paper. Economic projections for 1972, and 1973 are done in Section III of this paper. Section IV presents a conclusion with suggestions and discussions for the Third Five Year Plan and its execution.

II. THE MODEL

Selection of the sample size is considered to be very important in the model specification as it greatly affects the value of coefficients of the structural equations. Those which were derived from the larger sample size have rich statistical properties but do not seem to reflect the real economic structure of Korea; the converse case is true for those from the smaller sample size. In this section, therefore, we present two sets of structural equations for comparison, estimations of which were obtained by applying least square methods, based upon the data of 1957-1971 and those of 1960-1971. An even shorter sample period 1965-1971, was required for the estimation of some import and investment equations on account of the importance of those variables in the most recent years.

Each set of structural equations is designed to have two income determination systems, expressing GNP on the expenditure or demand side

and on the industrial origin or production side. The two systems approach GNP from different angles, and are mutually independent since a variable which is a dependent variable in one system is treated as exogenous if it enters in the other system as an independent variable. The gap thus obtained reflects "ex ante" disequilibrium between the aggregate demand and supply, which should disappear "ex post" through adequate adjustments.

The model contains 19 statistical equations, 14 identities, 33 endogenous variables, 7 exogenous policy variables, and 31 exogenous and lagged endogenous variables.

1. The Data

Basic data were mainly obtained from the publications of the Bank of Korea except for the data on employment and capital stock.

Because of discontinuity and incomparability in the series of employment data, it was necessary to construct a new series which covers the period 1957-1971. The work was done by KDI research staff; the 1963-1970 series published by the Bureau of Statistics, Economic Planning Board, was appropriately extended based upon the information obtained from the 1960 Population and Housing Census of Korea and the earlier series of the employment published by the Bureau of Statistics, Ministry of Internal Affairs.

The capital stock series was constructed by K. S. Lee,[1] Senior Fellow, KDI, using the stock figures obtained from Estimates of Korean Capital and Inventory Coefficients in 1968 by K. C. Han as a base.

---

[1] Lee [10]

All values, unless otherwise specified, were expressed in trtms of billions of won at 1965 prices. For those values which were only available in terms of current prices or dollars, appropriate deflators were used for the conversion. For instance, money supply was deflated by the wholesale price index, government revenue was deflated by the weighted index of government consumption deflator and government fixed capital formation deflator, and dollar values were converted by multiplying 265.4, the 1965 par value of the dollar in terms of won.

2. List of Variables

2.1 Endogenous Variables

V^a : Value added in agriculture, forestry, and fishing

V^m : Value added in mining and manufacturing

V^o : Value added in electricity, construction, water, sanitary service, transportation, storage and communications

V^s : Value added in wholesale and retail trades, banking and insurance, ownership of dwellings, public administration, defence, education and other service

V : GNP

C : Total consumption

C^p : Private consumption

C^g : Government consumption

I : Gross domestic capital formation

I^f : Gross domestic fixed capital formation

I^a : Gross fixed investment in the primary sector

I^m : Gross fixed investment in the mining and manufacturing sector

I^o : Gross fixed investment in the social overhead sector

I^s : Gross fixed investment in the service sector

I^i : Increase in stocks

M^k : Imports of machinery and equipment

M^d : Imports of intermediate goods for domestic use

M^x : Imports of intermediate goods for export

M^f : Imports of fuel

$M^g_{c.i.f.}$: Total imports of goods at CIF

$M^g_{f.o.b.}$: Total imports of goods at FOB

M : Total imports

V^{na} : Value added in the non-agricultural sector

S^g : Government saving, deflated by gross domestic capital formation deflator

K^a : Beginning-of-year capital stock in the primary sector

K^m : Beginning-of-year capital stock in the mining and manufacturing sector

K^o : Beginning-of-year capital stock in the social overhead sector

K^s : Beginning-of-year capital stock in the service sector

D^a : Depreciation allowance for fixed capital in the primary sector

D^m : Depreciation allowance for fixed capital in the mining and manufacturing sector

D^o : Depreciation allowance for fixed capital in the social overhead sector

D^s : Depreciation allowance for fixed capital in the service sector

2.2 Exogenous Policy Variables

M : Money supply outstanding

GR : Government revenue

DT : Direct tax, deflated by the GNP deflator

P^m : Exchange rate on imports

PiFPiw : Domestic fuel price index, deflated by wholesale price index

Mgr : Imports of grains

X^g : Total exports of goods

2.3 Exogenous Variables

L^a : Employment in the primary sector, thousands of persons

L^m : Employment in the mining and manufacturing sector

L^o : Employment in the social overhead sector

L^s : Employment in the service sector

V^f : Net factor income from the rest of the world

Fe : Fertilizer consumed, ten thousands of metric ton

M^s : Imports of service

X^s : Exports of service

t : Time trend (the first year of the sample period = 1)

D^W : Weather dummy variable

3. Production Functions

Four sectoral production functions, of the primary, mining and manufacturing, social overhead, and service sectors, respectively, were estimated to obtain industrial origin of GNP or aggregate supply. Each sectoral function is of Cobb-Douglas type, implying unitary factor substitution and homogeneity.

Estimation of these production functions was an attempt to refine and develop existing production theories in the field of macro-economic research of Korea. Each of them assumes three inputs for production, fixed capital, labor and liquid assets, except for the primary sector where fertiliser application is included instead of money. Lack of data and inconsistency had delayed estimation of Cobb-Douglas type production function with all those variables in Korea.

The most distinctive feature of these production functions is the inclusion of a financial variable as an explanatory variable. Attempts to estimate such production functions have yet to appear in the economic literature, to the extent of the author's knowledge. Therefore, some justification and elaboration is required in order not to be subject to open criticism.

Generally, monetary phenomena have been studied for short-run equilibruim analysis in empirical research work. Recently, a group of monetary economists led by the University of Chicago Professors have

endeavored to integrate the monetary sector with the real sector in a model of economic growth.[2]

Those theories, however, largely start from the proposition that cash balances influence consumption, saving, and investment behaviour by affecting utility functions and portfolio choices. Although a difference of assumptions is apparent between these theories and our production functions, it suggests to us a possibility of utilizing the money factor for the explanation of output growth.

Three basic assumptions underlie this incorporation of a financial variable, MS, into the neo-classical production function. They are:

1) A production unit is equipped with fixed capital goods and working capital. They are mutually substitutable within the finite planning horizon, and the ratio between them is planned according to the profit maximization principle of an individual firm.

2) Production activity of an individual firm is greatly affected by the availability of liquid assets. Disregarding the constraints given by amounts of order offered, a firm would contract or expand its production by laying-off or operating overtime according to its credit availability. MS is considered as the proxy variable of the aggregate liquid assets of the production units, private or public.

3) MS yields its own marginal products. Returns to the services rendered by MS are paid as interest and dividend payments, which are,

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[2] Sidrauski [11, pp. 575-585]; Sidrauski [12]; Johnson [5, pp. 265-87]; Friedman [3]; Gurley and Shaw [4]; Tobin [13, pp. 676-684] and Patinkin [12]

in turn, based upon the social opportunity cost of money.

Thus the general form of our new production function is:

(i) $V = AL^{\alpha}K^{\beta}MS^{\gamma}$

Where $1>\alpha>0$, $1>\beta>0$, $1>\gamma>0$

and $\alpha+\beta+\gamma = 1$

giving:

(ii) $V = AL^{\alpha}(K^{\beta/(1-\alpha)}MS^{1-\beta/(1-\alpha)})^{1-\alpha}$

(iii) $= AL^{\alpha}(K(MS/K)^{1-\beta/(1-\alpha)})^{1-\alpha}$

In equation (i), MS is defined as an independent factor of production, to be substituted freely for L and K, with its marginal products expressed as:

$$\frac{\partial V}{\partial MS} = \gamma\frac{V}{MS} = (1-\alpha-\beta)\frac{V}{MS}$$

where the value of γ is determined independently from L and K.

Equation (ii) defines MS as working capital which is substitutable only for K, the fixed capital goods. This only decomposes a firm's assets into two different types of capital for the comparison of their different productivities. Thus the marginal product of MS is:

$$\frac{\partial V}{\partial MS} = \frac{\partial V}{\partial K} \cdot \frac{\partial \bar{K}}{\partial MS} = (1-\alpha)\frac{V}{K}\left(1-\frac{b}{1-\alpha}\right)\frac{\bar{K}}{MS}$$

$$= (1-\alpha-\beta)\frac{V}{MS}$$

where K is defined as total capital or MS+K. Although the outcome is the same as that of equation (i), its implications are different in that it assumes two broadly defined factors of production, but not the

homogeneity of one of those factors whereas equation (i) assumes three factors of production.[3]

Equation (i) assumes two factors of production, where K is defined as real fixed capital, and MS as the capacity utilization variable of capital goods. MS contributes to production only to the extent that it increases the rate of utilization of capital goods, and its services are paid from the share of capital. Therefore, unless MS/K is not assumed to affect utilization, that is $\gamma=0$, the rate of utilization reaches the maximum when MS/K=1.

Whether to treat this financial variable as a factor of production, distinguished as an alternative asset to real capital, as in equation (ii), or as an independent factor from capital or labor, as in equation (i), is a hypothesis to be further developed theoretically. M. J. Bailey shares this position, and states:

> "Whether or not cash balances are a variable independently influencing the relation between consumption and income, there is no question that they are a factor of production. ----- To some extent it is clearly true that real cash balances are a factor of production; they reduce the other resources required for a given level of production, by facilitating payments. -----Cash balances held by business firms are obviously a productive service similar to any other.

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[3] The same can also be done for the labor factor by disaggregating it according to skill calssification, or for capital goods, by decomposing machinery according to its efficiency, such as domestic-made or imported in the dual economy. Therefore, if the homogeneity of capital factors is assumed, that is, $\beta=\gamma$, then it becomes the usual neo-classical two-factor production function, and only the definition of capital differs from that of equation (ii).

---------- It should be noted that the proposition that real cash balances are a factor of production, which is necessarily true, is distinct from the proposition that they are a function in the consumption function, which need not be true.[4]

It is quite reasonable to assume that the financial variable is a factor of production. From a micro-economic standpoint, it is the working capital that constrains the level of production. Government fiscal and monetary policies are largely aimed to stimulate production in addition to the purpose of attaining stabilization of the economy. Such is especially true in the Korean economy, where the Government development plans lead the growth path of the private sector, and import, fiscal and financial policies are considered as a choice between growth and stabilization.[5]

For those who take a less positive position on the role of the financial variable in the production function, it may be interpreted as a mere capacity utilization variable as in equation (iii).[6]

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[4] Bailey [2, pp. 59-61]

[5] In addition, it was impossible to estimate the Cobb-Douglas type production functions without introducing this variable. Statistical data used to be blamed for its failure. But the new production functions fit very well, which may both demonstrate the relevance of introducing the financial variable and improve our confidence in our statistical data.

[6] This is only a conceptual difference; the extent that MS affects the production function (the deduced coefficient of MS) is the same for each equation: This, however, reduces the chance of being involved in criticism concerning the definitions and assumptions of the production function.

techniques that utilize capacity adjustment variables describing the rate of utilization have been occasionally used for the estimation of production functions.[7] This increases efficiency in estimating structural equations and projections. Introduction of the weather dummy variable and fertilizer application falls in this case.

3.1 Production Function of the Primary Sector

Primary sector value added was assumed to be a function of beginning-of-year capital stock, labor, fertilizer application and weather conditions. In addition to two basic factors of production, an intermediate input, chemical fertilizer application, entered in the production function as an explanatory variable which influences factor productivity change.

The land variable was not used in the equation due to its characteristic of fixed supply, but its productivity change was explained by fertilizer input and weather conditions. Weather dummy is chosen by extrapolating time series data of agricultural output such that it takes values of -1, 0, and +1 for unfavorable, neutral, and favorable weather conditions.

$$\text{(1A)}\quad \log \frac{Y^a}{L^a} = \underset{(0.146)^*}{-0.455} + \underset{(0.013)}{0.030}\, D^W + \underset{(0.062)}{0.621} \log \frac{K^a}{L^a} + \underset{(0.027)}{0.067} \log \frac{Fe}{L^a}$$

$$R^2 = 0.969 \ (1957\text{-}1971)^{**}$$

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[7] Klein, Ball, Hazlewood and Vandome [7, pp. 51-52]; Adelman and Kim [1, pp. 80-81]

* The number in parentheses denotes standard error of each coefficient.

** This denotes the sample observation period.

$$(1B)\ \log \frac{V^a}{L^a} = \underset{(0.121)}{-0.666} + \underset{(0.011)}{0.052}\, D^w + \underset{(0.046)}{0.566} \log \frac{K^a}{L^a} + \underset{(0.019)}{0.056} \log \frac{Fe}{L^a}$$

$$R^2 = 0.982\ (1960\text{-}1971)$$

The obtained function indicates relatively low marginal productivity of labor (MPL), which explains labor intensive nature of Korean agriculture. Outward migration of labor and capital formation in the agricultural sector, however, has raised MPL by 67 per cent, from 14,960 won to 24,950 won, over the sample period 1957-1971. Meanwhile, output has grown by 63 per cent, and marginal productivity of capital (MPK) decreased by 20 per cent. Whereas growth of capital stock was the largest factor in output growth, accounting for 94 per cent of the annual output growth rate of 3.6 per cent, the contribution on the part of labor has been negative.[8]

Fertilizer input was also an important determinant of agricultural production which accounted for the rest of output growth. During the late 1950's and earlier 1960's fertilizer input was especially significant in inducing output growth of this sector.[9]

The estimated function also found out the dependency of agricultural production upon weather conditions, indicating a 6 per cent range of output fluctuation between good-crop and bad-crop years.

Comparing two estimates of the production function based on samples of different sizes, we find that the coefficients for capital and fertilizer are decreasing, and those for labor and the dummy variable

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[8] See Appendix I for the detai

[9] See Appendix I.

ncreasing. It accords with our general observation that the efficiency of capital and fertilizer is decreasing due to continuing capital formation and chemical fertilizer application, and that labor productivity is increasing due to the slower rate of growth of the labor force than that of capital stock and fertilizer use. The higher coefficient for weather dummy seems to reflect the more abrupt change of weather conditions in the 1960's.

3.2 Production function of the mining and manufacturing sector

This sector production function incorporates money supply and technical change into the general Cobb-Douglas type production function. The function assumes constant ratio of money supply to the holding of liquid assets of each sector over the sample period.

$$\text{(2A)}\quad \log \frac{V^m}{L^m} = \underset{(0.28)}{-1.562} + \underset{(0.29)}{0.641} \log \frac{K^m}{L^m} + \underset{(0.12)}{0.133} \log \frac{MS}{L^m} + \underset{(0.017)}{0.0743}\, t$$

$$R^2 = 0.945 \ (1957\text{-}1971)$$

$$\text{(2B)}\quad \log \frac{V^m}{L^m} = \underset{(0.13)}{-1.334} + \underset{(0.15)}{0.657} \log \frac{K^m}{L^m} + \underset{(0.064)}{0.164} \log \frac{MS}{L^m} + \underset{(0.0092)}{0.0842}\, t$$

$$R^2 = 0.988 \ (1960\text{-}1971)$$

It was found that the growth elasticity of output was 0.641, 0.226, and 0.133 with respect to fixed capital, labor, and money supply, respectively.

As discussed in the previous pages, the coefficient for money supply has different implications depending upon the definition of this variable. Treating this variable as working capital, coefficient for capital in the broad sense was 0.774, where it was 0.641 for fixed cap-

ital and 0.133 for working capital. If we regard MS/K as a capacity utilization variable for fixed capital, coefficient for fixed capital was 0.774, where the coefficient for MS/K was 0.465. For each case, the production function was reduced to the following forms:

$$(2Aa) \quad V^m = 0.210e^{.074t} L^{m.226} (K^{m.828} MS^{.172})^{.774}$$

and

$$(2Ab) \quad V^m = 0.210e^{.074t} L^{m.226} (K^m(\frac{MS}{K^m})^{.465})^{.774}$$

A relatively low coefficient for labor as compared with that of capital as a whole reflects the production structure of developing countries. The capital-output ratio has been steadily decreasing, from 5 in 1957 to 1.5 in 1971, implying utilization of existing capital stock during the sample period with the aid of expansionary monetary policy. Marginal productivity of working capital (MPMS), accordingly decreased by 2 per cent, while MPL has increased by 127 per cent, from 34,100 won to 77,400 won, and MPK by 259 per cent.

The average annual growth rate of 14.7 per cent during the sample period may be divided into a contribution of 12.8 per cent of the part of labor, 21.8 per cent through fixed capital formation, 13.7 per cent through growth of money supply, and 50.6 per cent from the total productivity factor.[10] Assuming this total productivity increase is equally distributed, the contribution ratio becomes 45 per cent for capital, 27 per cent for labor, and 28 per cent for money supply. The contribution of capital was especially high since the mid-1960s; it accounted for 29.7 per cent of the annual output growth during 1965-1971 against only 13.5 per cent during 1957-1965.

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[10] See Appendix I.

Elasticity of output growth with respect to labor is lower in equation (2B) than that in equation (2A). This reflects faster growth of MPK than that of MPL due to labor absorption.

3.3 Production Function for the Social Overhead Sector

Output of this sector was also assumed to be a function of labor, fixed capital, money supply and technical progress.

$$\text{(3A)}\quad \log \frac{V^o}{L^o} = \underset{(0.413)}{-2.548} + \underset{(0.244)}{0.848} \log \frac{K^o}{L^o} + \underset{(0.158)}{0.053} \log \frac{MS}{L^o} + \underset{(0.011)}{0.077}\, t$$

$$R^2 = 0.924 \ (1957\text{-}1971)$$

$$\text{(3B)}\quad \log \frac{V^o}{L^o} = \underset{(0.45)}{-2.184} + \underset{(0.31)}{0.629} \log \frac{K^o}{L^o} + \underset{(0.19)}{0.110} \log \frac{MS}{L^o} + \underset{(0.012)}{0.079}\, t$$

$$R^2 = 0.928 \ (1960\text{-}1971)$$

As in the case of the production function for mining and manufacturing, equation (3A) was reduced to:

$$\text{(3Aa)}\quad V^o = 0.0782\, e^{.077t}\, L^{o.099}\, (K^{o.941} MS^{.059})^{.90}$$

and

$$\text{(3Ab)}\quad V^o = 0.0782\, e^{.077t}\, L^{o.099}\, (K^o (\frac{MS}{K^o})^{.1})^{.901}$$

The growth elasticities of output were found to be 0.848, 0.099, and 0.053 with respect to fixed capital, labor, and money supply. The effect of capital formation in inducing production was dominant while those of labor and of money supply were negligible, which should be largely due to the shortage of production capacity and full capacity operation in this sector.

Equation (3A), however, does not seem to reflect the real production structure of this sector at present, since this shortage has disappeared as a result of the sizeable capital formation in this sector during the second half of the 1960's. This can be seen more clearly by a comparison of the two production functions; equation (3B), the estimation of which relied more upon the recent behaviour of variables, shows much higher coefficients for labor and money supply, and a lower one for net capital stock.

During the period 1957-1971, the capital-output ratio decreased from 13.7 to 5.4. MPL went up by 128 per cent, MPK by 154 per cent and MPMS by 1 per cent. The average growth rate of output in this sector of 14.9 per cent was mostly attributable to the growth of capital-stock, explaining 40.8 per cent of output growth against 5.3 per cent for employment increase, 5.0 per cent for money supply and the rest for total productivity factor. [11]

3.4 Production Function for the Service Sector

Production in this sector was related to capital stock, labor and the money supply. [12]

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[11] See Appendix I.

[12] In view of the fact that this sector is generally regarded as a sponge sector for other sectors, the trend variable was deliberately not used in the estimation.

$$(4A)\ \log \frac{V^s}{L^s} = -\underset{(0.18)}{0.736} + \underset{(0.094)}{0.213} \log \frac{K^s}{L^s} + \underset{(0.054)}{0.376} \log \frac{MS}{L^s} \qquad ^{13}$$

$$R^2 = 0.809\ (1957\text{-}1971)$$

giving:

$$(4Aa)\quad V^s = 0.497\ L^{s.411}\ (K^{s.362} MS^{.638})^{.589}$$

and

$$(4Ab)\quad V^s = 0.479\ L^{s.411}\ (K^s(\frac{MS}{K^s})^{1.506})^{.589}$$

The growth elasticity of output was found to be 0.213 for fixed capital, 0.411 for labor and 0.376 for money supply. It indicates that increases in liquid assets and employment largely expanded output in this sector during the sample period.

The effect of MS in inducing output is so strong in this sector that it cannot be safely regarded as a mere capacity utilization variable. In fact, the even higher coefficient for money supply than that of fixed capital indicates that liquid assets are an even more important factor of production than fixed capital. Credit availability was an especially constraining factor during the earlier phase of Korean economic development. As the tight credit condition has been eased, MPMS in 1971 has decreased to two-fifths of the 1957 level. This expansion of credit supply accounted for 70.3 per cent of the growth of value-added in the sector against 25.8 per cent from the employment increase and 3.9 per cent from the growth of capital stock.

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13 The alternative function gives:

$$(4B)\ \log \frac{V^s}{L^s} = \underset{(0.15)}{-0.794} - \underset{(0.10)}{0.051} \log \frac{K^s}{L^s} + \underset{(0.044)}{0.369} \log \frac{MS}{L^s} \qquad R^2 = 0.924\ (1960\text{-}1971)$$

which indicates negative MPK. Although a low correlation between capital and value added in this sector was expected, this extraordinarily low coefficient for capital has limited practical usefulness in this function.

The low coefficient for the capital stock indicates a relative abundance of capital stock in the earlier stage of the sample period. Despite the fact that further fixed capital formation was continued sufficiently to reduce the capital-output ratio to 4.4 in 1971 from 10 in 1971, MPK still went up by 126 per cent, due to faster rate of growth of money supply than that of capital. MPL, however, did not rise so fast, probably because of the relatively high MPL during the initial period and the high growth of employment in this sector.

4. Depreciation Equations

A fixed marginal rate of depreciation to the beginning-of-year capital stock was applied in the estimation of the depreciation equations. Data for the depreciation allowance for fixed capital were taken as a proxy variable for depreciation and obsolescence, as no other information was available.

(5A) $D^a = -7.632 + 0.069\ K^a$ $\quad R^2 = 0.981$
(0.485) (0.0028) (1957-1970)

(5B) $D^a = -8.141 + 0.072\ K^a$ $\quad R^2 = 0.980$
(0.64) (0.0035) (1960-1970)

(6A) $D^m = -49.031 + 0.147\ K^m$ $\quad R^2 = 0.984$
(2.49) (0.0054) (1957-1970)

(6B) $D^m = -52.057 + 0.152\ K^m$ $\quad R^2 = 0.990$
(2.49) (0.0052) (1960-1970)

(7A) $D^o = -10.219 + 0.0042\ K^o$ $\quad R^2 = 0.915$
(2.04) (0.0037) (1957-1970)

(7B) $D^o = -9.576 + 0.041\ K^o$ $\quad R^2 = 0.893$
(2.79) (0.0048) (1960-1970)

(8A) $D^s = -72.419 + 0.045\ K^s$ $\quad R^2 = 0.926$
(7.28) (0.0037) (1957-1970)

(8B) $D^s = -81.158 + 0.050\ K^s$ $\quad R^2 = 0.943$
(8.09) (0.0041) (1960-1970)

Any of these equations shows high marginal rate of depreciation which may imply a relatively high rate of obsolescence and substitution of machinery in the economy.

5. Consumption Functions

Consumption expenditures were disaggregated into private consumption and public consumption. Such disaggregation was necessary in view of differences in consumption behaviour between two sectors.

5.1 Private Consumption Expenditure

In an attempt to determine the different consumption patterns of the rural and non-rural sectors, income was disaggregated into agricultural income and non-agricultural income. The hypothesis of different marginal propensities to consume is worth a test in view of the dualistic nature of living standards between urban and rural dwellers.

Further, the Duesenberry-Modigliani type ratchet effect was tested so as to measure consumption response to cruuent income and previous consumption. Hence the function takes the form:

$$C_t^p = c_1 Y_t^a + c_2 Y_t^{na} + c_3 C_{t-1}^p + a$$

where Y^a and Y^{na} represent rural income and urban income. MPC is approximately $\frac{c_1}{1-c_3}$ for the rural sector and $\frac{c_2}{1-c_3}$ for the non-rural sector, if assumed that relative income levels are constant over time.[14]

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[14] MPC for the rural sector is:

$$\frac{\partial C_t^p}{\partial Y} = c_1 + c_3 \frac{\partial C_{t-1}}{\partial Y_t^a}.$$

In both cases agricultural output and non-agricultural output were used as proxy variables to rural and non-rural income. A further adjustment was made by deducting direct taxes from non-agricultural output on the assumption that direct taxes do not affect the disposable income level of the rural sector but do affect that of the urban sector, and that indirect taxes and transfers affect income levels of the two sectors proportionally. Two stage least squares were also applied in the estimation only for the purpose of reference.[15]

(9Aa) $C^p = \underset{(37.64)}{90.143} + \underset{(0.11)}{0.496}(V^{na}-DT) + \underset{(0.10)}{0.160}\ V^a + \underset{(0.16)}{0.459}\ C^p{-1}$

$R^2 = 0.999$ (1957-1971)

(9Ab) $C^p = \underset{(23.31)}{182.643} + \underset{(0.021)}{0.800}(V^{na}-DT) + \underset{(0.11)}{0.311}\ V^a$ $R^2 = 0.9987$ (1957-1971)

(TSLS) $C^p = \underset{(40.01)}{181.556} + \underset{(0.037)}{0.800}(V^{na}-DT) + \underset{(0.19)}{0.316}\ V^a$ $R^2 = 0.996$ (1957-1971)

14

where $C^p_{t-1} = c_1 Y^a_{t-1} + c_2 Y^{na}_{t-1} + c_3 C^p_{t-2} + a$

If all past incomes are assumed to be equal, then it properly reduce to:

$$\frac{\partial C^p_t}{\partial Y^a_t} = c_1(c + c_3 + c_3^2 \ldots) = c\left(\frac{1}{1-c_3}\right) \quad \text{since } \frac{\partial C^p_{t-1}}{\partial Y^a_{t-1}} = c_1 + c_3 \frac{\partial C^p_{t-2}}{\partial Y_{t-1}}$$

And the same applies to MPC for the non-rural sector. As this assumtion is not relevant in the Korean context where past incomes were on the rising trend, MPC for sector i should be less than $c_i\left(\frac{1}{1-c_3}\right)$. It can only be used as an approximate to MPC.

15

TSLS estimators are inefficient in a case where the predetermined variables are lagged endogeneous variables, since the residuals of the regression equations were highly correlated. Moreover, it was hard to expect the efficiency of TSLS in obtaining consistent estimators because of relatively short sample observation period. Considering their mutual interdependence, significance and multicollinearities, the following variables were selected for the TSLS estimation: C^g, I, M^X+M^{gv}, X^g, $M^{gr}+M^r$, PiFPiw, V^a.

(9Ba) $C^p = 107.993 + 0.529(V^{na}-DT) + 0.14\ V^a + 0.412\ C^p{-1}$
(62.07) (0.16) (0.12) (0.23)

$R^2 = 0.999$ (1960-1971)

(9Bb) $C^p = 210.162 + 0.809(V^{na}-DT) + 0.213\ V^a$ $R^2 = 0.9987$
(29.04) (0.022) (0.13) (1960-1971)

(TSLS) $C^p = 210.223 + 0.809(V^{na}-DT) + 0.211\ V^a$ $R^2 = 0.997$
(41.87) (0.032) (0.18) (1960-1971)

It was observed that the MPC of the non-rural sector is between 0.8-0.9, whereas that of rural sector is around 0.3, indicating a highly dualistic consumption structure.[16] It was further found that such unbalanced consumption patterns are a continuing characteristic in Korea, as we compare two groups of estimated consumption functions based upon different sample observations.

5.2 Government Consumption Expenditure

Government expenditure was related to government revenue.[17]

(10A) $C^g = 49.505 + 0.331\ GR$ $R^2 = 0.975$ (1957-1971)
(1.98) (0.015)

(10B) $C^g = 47.835 + 0.339\ GR$ $R^2 = 0.974$ (1960-1971)
(2.59) (0.018)

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16 The marginal propensities to consume are derived as 0.92 for non-rural sector and 0.30 for rural sector from equation 9Aa.

17 Attempts were made to estimate other equations with additional variables such as lagged endogenous variable and number of government employees (N^g).
They are:

$C^g = 13.923 + 0.150\ GR + 0.683\ C^g_{-1}$ $R^2 = 0.974$
(8.35) (0.043) (0.16) (1957-1971)

$C^g = 67.232 + 0.406\ GR + 0.085\ N^g$ $R^2 = 0.978$
(12.65) (0.055) (0.060) (1957-1971)

$C^g = 6.192 + 0.115\ GR + 0.024\ N^g + 0.736\ C^g_{-1}$ $R^2 = 0.990$
(18.83) (0.088) (0.051) (0.20) (1957-1971)

6. Investment Functions

In accordance with the policy orientation of this model, the fixed capital formation function was designed to focus on the effects of shocks from outside and to have maximum forecasting capacity. Therefore, emphasis was given to estimating significant coefficients for financial variables such as government non-consumption expenditure and money supply.

Sectoral disaggregation of fixed capital formation was in line with that of production. Except for the mining and manufacturing sector, each sectoral function was of the accelerator type, including past change of output and the lagged endogenous variable. A lagged endogenous variable was introduced in the equation in order to supplement the limitation of this equation in explaining variations of investment demand caused by under- or over- utilization of capacity. Thus the general form of equation is:

$$I_t = v_1 \Delta V_{t-1} + v_2 I_{t-1} + a$$

17

$$C^g = \underset{(8.93)}{13.713} + \underset{(0.048)}{0.158}\ GR + \underset{(0.17)}{0.672}\ C^g_{-1} \qquad R^2 = 0.990 \quad (1960\text{-}1971)$$

$$C^g = \underset{(16.65)}{63.232} + \underset{(0.065)}{0.397}\ GR - \underset{(0.075)}{0.070}\ N^g \qquad R^2 = 0.976 \quad (1960\text{-}1971)$$

$$C^g = \underset{(21.03)}{-2.699} + \underset{(0.095)}{0.087}\ GR + \underset{(0.059)}{0.051}\ N^g + \underset{(0.21)}{0.075}\ C^g_{-1} \qquad R^2 = 0.991 \quad (1960\text{-}1971)$$

Although the fitting of each equation was good, they did not give stable estimators as the sample sizes differ.

If assumed that past income changes are constant over time, the investment accelerator becomes $\frac{v_1}{1-v_2}$ [18]

6.1 Gross Fixed Investment in the Primary Sector

Investment demand in this sector was assumed to be determined by the investment level of the previous year, past changes of value added in this sector and government non-consumption expenditures. Because of wide range of fluctuations of agricultural output in the past, averages of the change in agricultural production in the last two years were used to determine the accelerator coefficient. The financial condition of this sector was assumed to be affected by the non-consumption expenditures, but only slightly by the money supply.

$$\text{(11A)} \quad I^a = \underset{(3.07)}{6.411} + \underset{(0.06)}{0.120}\, S^g + \underset{(0.33)}{0.334}\, I^a + \underset{(0.07)}{0.093}\, \frac{(\Delta V^a_{t-1} + \Delta V^a_{t-2})}{2}$$

$$R^2 = 0.922 \ (1957\text{-}1971)$$

$$\text{(11B)} \quad I^a = \underset{(3.69)}{6.981} + \underset{(0.06)}{0.121}\, S^g + \underset{(0.38)}{0.300}\, I^a + \underset{(0.09)}{0.108}\, \frac{(\Delta V^a_{t-1} + \Delta V^a_{t-2})}{2}$$

$$R^2 = 0.904 \ (1960\text{-}1971)$$

Investment levels in this sector appear to be greatly dependent upon the direction of government fiscal policies, especially government investment. The investment accelerator is between 0.09-0.15, indicat-

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[18]

$$I_t = v_1 \Delta V_{t-1} + V_2 I_{t-1} + a$$

which expands to:

$$I_t = \sum_{i=0}^{\infty} (v_1 v_2^i \Delta V_{t-i-1} + v^i a)$$

If

$$\Delta V_{t-1} = \Delta V_{t-2} = \ldots = \Delta V_{t-i-1}, \text{ then:}$$

$$I_t = \sum_{i=0}^{\infty} (v_1 v_2^i \Delta V_{t-1} + V^i a) = \frac{v_1}{1-v_2} (\Delta V_{t-1} + a)$$

ing a lack of self-financing ability for capital formation in this sector. The high coefficient for its own lagged value represents a positive dynamic adjustment in the investment demand for agricultural output. The equation as a whole reflects rather the autonomous nature of this investment.

6.2 Gross Fixed Investment in The Mining and Manufacturing Sector

The investment demand equation of this sector was assumed to be a function of the lagged value of imports of capital goods and the money supply. As priority was given to obtaining a significant coefficient for the financial variable in the equation, it was necessary to omit some variables with theoretical justification on account of the strong multicollinearity with the money supply.[19] Besides, the past investment bahaviour appeared to have a strong tendency to catch up with the trend, which had limited the use of lagged values of investment and past changes of production.

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[19] Alternative equations which were estimated but dropped in the model specification because of these reasons are:

$$I^m = 6.746 + \underset{(0.533)}{1.156}\,\Delta V^m_{-1} + \underset{(0.113)}{0.082}\,(MS + S^b)$$
$$R^2 = 0.9005 \ (1960\text{-}1970)$$

$$I^m = 6.021 + \underset{(0.343)}{1.401}\,\Delta V^m_{-1} + \underset{(0.129)}{0.077}\,MS$$
$$R^2 = 0.914 \ (1955\text{-}1970)$$

$$I^m = -0.539 + \underset{(0.185)}{0.388}\,M^k_{-1} + \underset{(0.435)}{2.070}\,MS - \underset{(8.286)}{8.173}\,\Delta V^m_{-1}$$
$$R^2 = 0.954 \ (1957\text{-}1971)$$

$$I^m = -0.615 + \underset{(0.255)}{0.480}\,M^k_{-1} + \underset{(0.508)}{2.060}\,MS - \underset{(12.609)}{12.541}\,\Delta V^m_{-1}$$
$$R^2 = 0.947 \ (1960\text{-}1971)$$

In this equation, past levels of imports of capital goods were substituted for past changes in value added for the evaluation of the accelerator coefficient in this sector. As will be seen in the import equations, imports of capital goods are, in turn, determined by the level of fixed investment. Therefore, it may be said that this model assumes a multiplier-accelerator relation between imports of capital goods and investment in the mining and manufacturing sector.

$$\text{(12A)} \quad I^m = \underset{(13.32)}{2.920} + \underset{(0.29)}{0.206}\, M^k_{-1} + \underset{(0.31)}{0.389}\, MS \qquad R^2 = 0.858 \quad (1957\text{-}1971)$$

$$\text{(12B)} \quad I^m = \underset{(19.77)}{3.296} + \underset{(0.38)}{0.169}\, M^k_{-1} + \underset{(0.42)}{0.416}\, MS \qquad R^2 = 0.838 \quad (1960\text{-}1971)$$

The estimated equation indicates that investment demand in this sector is largely determined by the availability of domestic financing. The equation also shows that the accelerator coefficient of imports of capital goods in inducing capital formation in this sector is 0.2, which reflects a rather low dependency of investment demand upon the availability of imported machineries. Comparison of the two equations based upon different sample observations further indicates that the dependency of the investment demand upon financial availability is higher and that upon imports availability is lower in the recent period.

6.3 Gross Fixed Investment in The Social Overhead Sector

Fixed investment in social overhead was related to the change in non-agricultural production in the previous year, the lagged value of investment of the sector, and government non-consumption expenditures. In consideration of the public nature of this investment and the

externalities it involves, the availability of government finance and the change in non-agricultural production were assumed to affect investment demand in this sector.

$$(13A)\quad I^o = \underset{(8.81)}{22.016} + \underset{(0.30)}{0.877}\, S^g + \underset{(0.19)}{0.034}\, I^o_{-1} + \underset{(0.26)}{0.368}\Delta V^{na}_{-1}$$

$$R^2 = 0.974 \ (1957\text{-}1971)$$

$$(13B)\quad I^o = \underset{(10.45)}{22.055} + \underset{(0.40)}{0.941}\, S^g + \underset{(0.23)}{0.014}\, I^o_{-1} + \underset{(0.33)}{0.341}\Delta V^{na}_{-1}$$

$$R^2 = 0.969 \ (1960\text{-}1971)$$

$$(13C)\quad I^o = \underset{(14.13)}{6.245} - \underset{(0.35)}{0.074}\, I^o_{-1} + \underset{(0.62)}{0.634}\Delta V^{na}_{-1} + \underset{(1.20)}{1.025}\, S^g$$

$$R^2 = 0.968 \ (1965\text{-}1971)$$

The estimated coefficients differ a great deal in three equatior indicating that the function relationship has been changing in the last 15 years. This sector was initially endowed with little capital stock, and sizeable investment has followed subsequently, especially during the second half of the 1960's, which has resulted in sufficier and probably excess capacity in this sector.

The investment accelerator coefficient lay between 0.34-0.63 with respect to the change in non-agricultural value added, and the multiplier between 0.88 - 1.03 with restpct to government financing during the sample periods. It may be said that there was little dynamic adjustment in the behaviour of investment demand in this sector.

6.4 Gross Fixed Investment in The Service Sector

In this sector investment demand was assumed to be derived from this sector's production change in the previous year and availabilit

of financing.

$$(14A)\quad I^s = -5.880 + 0.322\Delta V^s_{-1} + 0.359\ MS + 0.438\ I^s_{-1}$$

$$R^2 = 0.986\ (1957\text{-}1971)$$

$$(14B)\quad I^s = \underset{(5.36)}{-5.901} + \underset{(0.25)}{0.347\Delta V^s_{-1}} + \underset{(0.22)}{0.381\ MS} + \underset{(0.36)}{0.434\ I^s_{-1}}$$

$$R^2 = 0.983\ (1960\text{-}1971)$$

The functional relationship was quite consistant in two sample periods. The accelerator coefficient with respect to the past change of its own production is 0.32. The high coefficient for money supply, 0.36, indicates heavy dependency of its investment demand upon financial availability. The coefficient for the lagged term represents dynamic response of investment in this year to that in the previous year: an initial rise calls for a subsequent secondary rise.

6.5 Changes in Inventory

Accumulation of inventory was related to the change in agricultural production and in non-agricultural production. In general, the statistical fits were poor, probably because of inaccuracies in data.

$$(15A)\quad I^i = \underset{(4.28)}{-0.142} + \underset{(0.14)}{0.483\Delta V^a} + \underset{(0.11)}{0.478\Delta V^m}$$

$$R^2 = 0.704\ (1957\text{-}1971)$$

$$(15B)\quad I^i = -4.122 + 0.457\Delta V^a + 0.556\Delta V^m$$

$$R^2 = 0.781\ (1960\text{-}1971)$$

The dependency of inventory accumulation upon the production changes in the agricultural sector and in the mining and manufacturing sector are both 0.48. But the dependency upon changes in mining and manufacturing production becomes higher according to equation

(15B), which probably reflects the more round-about production and sales structure of the sector in the recent period.

7. Import Functions

Total imports are disaggregated into 6 categories: (1) imports of machinery and equipment, (2) intermediate goods for domestic demand, (3) intermediate goods for exports, (4) fuels, (5) grains and (6) services, of which the last two categories were treated as exogenous. Import functions in general are designed to evaluate the elasticity of price variables and the marginal propensity to import with respect to production, export, or fixed investment, and the dynamic response of this year's imports to the previous level of imports. The price variable was computed in the following way:

$$P^m = (OER + TMR) \cdot \frac{PI^x_{us\ jap}}{PI^W}$$

P^m : real exchange rate on imports

OER: official exchange rate

TMR: amount of effective tariffs per dollar-import, which takes account of (1) actual tariff collection, (2) foreign exchange tax, (3) tariff exemption and (4) premiums for exports.[20]

$PI^x_{us\ jap}$: export price index of the U.S. and Japan, weighted by the amount of imports from each country, 1965=100

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[20] The figures were obtained from Kim [7]

PI^w: domestic wholesale price index, 1965=100, which should reflect the real and relative exchange rate on imports.

7.1 Imports of Machinery and Equipment

In this category imports were related to the level of fixed investment and the exchange rate on imports, and account was taken of dynamic response. Imports of capital goods were greatly increased in recent years, which might have entailed changes in the structural relationship. Therefore, long-term observation of samples did not appear, so as to increase the reliability of the estimated equations. Rather, an estimation based upon a short sample period would give a better analysis for imports of capital goods.

$$\text{(16A)} \quad M^k = \underset{(13.30)}{1.656} + \underset{(0.066)}{0.443}\, I^f - \underset{(0.060)}{0.095}\, P^m + \underset{(0.16)}{0.028}\, M^k_{-1}$$

$$R^2 = 0.986 \ (1957\text{-}1971)$$

$$\text{(16B)} \quad M^k = \underset{(33.89)}{30.009} + \underset{(0.073)}{0.441}\, I^f - \underset{(0.13)}{0.200}\, P^m + \underset{(0.18)}{0.026}\, M^k_{-1}$$

$$R^2 = 0.985 \ (1960\text{-}1971)$$

$$\text{(16C)} \quad M^k = \underset{(259.15)}{37.845} + \underset{(0.33)}{0.553}\, I^f - \underset{(0.79)}{0.291}\, P^m - \underset{(0.56)}{0.183}\, M^k_{-1}$$

$$R^2 = 0.978 \ (1965\text{-}1971)$$

Equation (16C) indicates that the marginal propensity to import with respect to fixed investment lies between 0.47-0.55, taking account of the coefficient for lagged terms.[21]

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[21] The same operation as in footnote 18 applies to the computation of the marginal propensity to import here. That is, if the level of imports of capital goods is assumed to be the same for every period, MPM with respect to fixed investment is 0.47 for equation (16C), 0.46 for equation (16A), and 0.45 for equation (16B).

Dependency of domestic fixed investment upon foreign capital goods was greater in recent period, as the third equation indicates. The exchang rate elasticity for this category imports is -0.69. The negative sign of the coefficient for the lagged term in equation (16C) reflects the effect of accumulation in both investment and imports of machinery and equipments.

7.2 Imports of Intermediate Goods for Domestic Demand

Imports of this category were assumed to be a function of value added in mining and manufacturing and the exchange rate, and dynamic adjustments were also taken account of.

$$(17A)\quad M^d = \underset{(22.81)}{98.833} + \underset{(0.067)}{0.417}\, V^m - \underset{(0.068)}{0.254}\, P^m - \underset{(0.22)}{0.197}\, M^d_{-1}$$

$$R^2 = 0.981 \ (1957\text{-}1971)$$

$$(17B)\quad M^d = \underset{(26.36)}{120.606} + \underset{(0.063)}{0.385}\, V^m - \underset{(0.070)}{0.340}\, P^m - \underset{(0.21)}{0.106}\, M^d_{-1}$$

$$R^2 = 0.987 \ (1957\text{-}1971)$$

Equation (17A) indicates that the marginal propensity to import, with respect to value added in mining and manufacturing lies between 0.35-0.42, and that the average elasticity with respect to the exchange rate is -0.63, which is lower than expected. However, equation (17B), based upon a shorter sample period, gives a lower marginal propensity to import and a higher exchange rate elasticity, indicating the effect of import substitution in the recent period. The coefficient for lagged terms represents the effect of accumulation in imports of intermediate goods for domestic uses.

7.3 Imports of Intermediate Goods for Exports

In this category, the import function took account of the import dependency of export goods and exchange rate. Only a very short sample observation was done in the estimation of the structural equation in view of the significance of this variable in the recent period.

$$(18) \quad M^x = \underset{(15.68)}{15.518} + \underset{(0.0095)}{0.448}\, X^g - \underset{(0.056)}{0.068}\, P^m$$

$$R^2 = 0.999 \ (1965\text{-}1971)$$

The coefficient for export goods indicates the marginal dependency of exports upon imports of raw materials and intermediate goods. The marginal earning ratio for the export industry is 0.45 and the exchange rate elasticity for imports of these goods is -0.06. The elasticity is low because the exchange rate affects track in both directions: a high exchange rate stimulates exports, which results in greater demand of intermediate goods, but restrains imports of these goods. The estimated equation indicates that the import substitution effects more than offset the export effects, so that a higher exchange rate would result in an absolute decrease in imports of intermediate goods for export demand.

7.4 Imports of Fuels

Imports of fuels were related to value-added in non-agriculture and relative price of fuels. Because petroleum accounts for almost all imports in this category, the domestic wholesale price index was deflated by the overall wholesale price index in order to represent the price variable in this equation.

$$(19A)\quad M^f = \underset{(5.43)}{-10.566} + \underset{(0.0038)}{0.044}\, V^{na} + \underset{(4.26)}{0.218}\, PiFPiw$$

$$R^2 = 0.928 \ (1957\text{-}1971)$$

$$(TSLS)\quad M^f = \underset{(5.29)}{-10.649} + \underset{(0.0037)}{0.044}\, V^{na} + \underset{(4.13)}{0.226}\, PiFPiw$$

$$R^2 = 0.932 \ (1957\text{-}1971)$$

$$(19B)\quad M^f = \underset{(6.53)}{-24.880} + \underset{(0.0041)}{0.052}\, V^{na} + \underset{(4.40)}{8.274}\, PiFPiw$$

$$R^2 = 0.960 \ (1960\text{-}1971)$$

$$(TSLS)\quad M^f = \underset{(6.29)}{-25.056} + \underset{(0.0040)}{0.052}\, V^{na} + \underset{(4.23)}{8.334}\, PiFPiw$$

$$R^2 = 0.963 \ (1960\text{-}1971)$$

$$(19C)\quad M^f = \underset{(11.73)}{-45.615} + \underset{(0.0039)}{0.059}\, V^{na} + \underset{(12.46)}{24.461}\, PiFPiw$$

$$R^2 = 0.983 \ (1965\text{-}1971)$$

As the demand for energy expanded in recent years, imports of fuels rose sharply, which resulted in a major burden in the balance of payments. The negative constant terms further indicate that this demand is exploding. According to equation (19C), which appears to reflect the present trend most relevantly, the price elasticity is 0.9, indicating that, regardless of fuel prices, import demand for fuels is increasing, but high fuel prices induce domestic suppliers to import more.

8. Identities

$$(20)\quad V = V^a + V^m + V^o + V^s + V^f$$

$$(21)\quad V = C + I + X - M$$

$$(22)\quad C = C^g + C^p$$

(23) $I^f = I^a + I^m + I^o + I^s$

(24) $I = I^f + I^i$

(25) $M^g_{c.i.f.} = M^k + M^d + M^x + M^f + M^{gr}$

(26) $M^g_{f.o.b.} = M^g_{c.i.f.} - (m^g_{c.i.f.} - M^g_{f.o.b.})$

(27) $M = M^g_{f.o.b.} + M^s$

(28) $V^{na} = V - V^a$

(29) $S^g = GR - C^g$

(30) $K^a = K^a_{t-1} - D^a_{t-1} + I^a_{t-1}$

(31) $K^m = K^m_{t-1} - D^m_{t-1} + I^a_{t-1}$

(32) $K^o = K^o_{t-1} - D^o_{t-1} + I^o_{t-1}$

(33) $K^s = K^s_{t-1} - D^s_{t-1} + I^s_{t-1}$

III. THE MODEL AS A FORECASTING INSTRUMENT

The model itself presents an over-indentified system in the determination of GNP, as it estimates aggregate demand and production from two alternative approaches. The "ex ante" gap which thereby resulted from two levels of GNP can be minimized by simulation of policy variables, but it can not possibly disappear "ex post" because of the stochastic estimation of the equations.

Since the major purpose of the model is to forecast future values of the unknowns with precision, a single set of policy variables is given such that it represents the most probable policy implementation in the short-term planning period. The model, then, forecasts two values of GNP, the lesser of which may be regarded as a constraint on the other. Those figures, however, should not differ greatly, since the major policy variable, MS, affects the levels of the two

estimates of GNP in the same direction. Values of the exogenous variables for the forecasts of 1972 and 1973 are presented in Table 1.

Value-added in non-agriculture, which is an explanatory variable in the formulation of the consumption and imports-of-fuels functions, has to be generated from the demand side such that:

$$\widehat{V^{na}} = \hat{C} + \hat{I} + X - \hat{M} - \hat{V}^{a}$$

where $\widehat{V^{na}}$, $\hat{C}$, $\hat{I}$, $\hat{M}$ and $\hat{V}^{a}$ represent the estimated values of those variables.

In practice, however, V^{na} was obtained from estimates of GNP from production side, because V^{na} obtained by simultaneous estimation of consumption and imports appeared greatly deviant from V^{na} obtained from production functions. These values are supposed to be identical "ex post", but different "ex ante" because of differences in the structural relations and the accumulation of errors in the stochastic equations. As it was reasoned that it was predominantly the latter terms, especially those which resulted from the estimation of GNP on demand side, which cause this deviation, the value of V^{na} was obtained from the income determination system of the production side in order to increase the efficiency in forecasting.

Each function was presented with a few alternative equations in the model description section. Each equation has different properties and implications in representing a structural relation, and a certain subjective judgement was inevitable to enter on the selection of equations for the forecast.

In the case of the production functions, it was considered that estimation based upon the larger sample observation, as noted "A" after the equation number, better reflected the production structure in Korea.

Table 1

Values of The Exogenous Variables

	1971	1972	1973	Sources
M^S	203.59	217.84	246.16	a
C^r	246.96	262.84	283.16	b
D^f	83.34	84.75	91.30	c
P^m	265.74	265.74	265.74	
PiFPiw	0.91	0.91	0.91	
Mgr	80.68	71.51	53.08	ORB figures
X^g	299.90	380.85	482.23	ORB figures
V^f	2.26	-22.26	-31.82	d
Fe	125.24	127.80	130.41	2.043%
M^s	114.92	147.03	163.49	ORB figures
X^s	130.58	116.78	119.96	ORB figures
D^w	0	0	0	
M^gc.i.f - M^gf.o.b	55.55	69.21	74.77	105 of M^gc.i.f
L^a	4,708.50	4,586.55	4,467.76	-2.59%
L^m	1,375.25	1,395.88	1,416.82	1.50%
L^o	713.25	758.11	805.80	6.29%
L^s	2,910.75	3,110.14	3,323.18	6.85%

Note:

a. 20% nominal growth rate for 1972 and 1973
b. 20% nominal growth rate for 1972 and 15% for 1973
c. FY 1972 Budget figure, and 15% nominal growth rate for 1973 (a,b,c, all assume 13% price increase rate for 1972 and 7% for 1973)
d. Projected figures form:

$$V^f = V^{fr} - V^{fp}$$
$$V^{fr} = IY^r - 0.842 + 0.322\ GOSVC^r$$
$$V^{fp} = IY^p - 1.731 + 0.317\ GOSVC^p$$

V^{fr} : Factor income from the rest of the world
V^{fp} : Factor income paid to the rest of the world
IY^r : Interest receipt from the rest of the world
IY^p : Interest payment to the rest of the world
$GOSVC^r$: Government and other service receipt
$GOSVC^p$: Government and other service payment

As consistency of forecasting was desired, projections of most of other values were also made on the basis of equations based upon a larger sample period, 1957-1971. In the forecasts of imports of intermediate goods for exports and fuels, however, equations estimated based upon the period 1965-1971 were used, taking account of the rapid structural changes in these demands. Consumption expenditures were forecasted on the basis of equation 9Aa.

Estimated values from these equations are further adjusted in consideration of the over-estimating tendency of these equations in very recent years. The statistical equations reflect very strongly the rising trend of the Korean economy in the 1960's, but the economy has apparently been settling back since 1971. There is no way to know whether this recess will continue or be only a temporary phenomenon. For a short-term forecasting model like this one, however, this tendency toward over-estimation has to be corrected in one way or another.

The performance of each equation was investigated for the last two or three years, and an index was constructed to represent the degree of overshooting or undershooting. This index, which we may call "a trend adjustment indicator" for each equation, is intended to reflect the actual growth relative to the growth of fitted value of a variable.

Ideally,

$$\frac{P_1}{P_o} = \frac{F_1}{F_o} \cdot \frac{A_1/A_o}{F_1/F_o}$$

where P, F, and A stand for the predicted, fitted and actual values of a variable, and the subscripts o and 1 represent the base year and the forecast year, respectively.

which reduces to:

$$\frac{P_1}{P_o} = \frac{A_1}{A_o}$$

then, this forecast is 100 per cent efficient.

Since we do not know A_1, trend adjustment indicator I has to be approximated by surveying past performance such that:

$$I^p = \frac{A_1/A_o}{F_1/F_o} \approx \frac{(\sum_{i=-n}^{o} A_i/A_i-1)/n+1}{(\sum_{i=-n}^{o} F_i/F_i-1)/n+1}$$

n=1, 2, whichever it is appropriate.

If $I^p = 1$, then the growth of fitted values gives an unbiased estimate. If $I^p > 1$ or $I^p < 1$, then it gives a systematic under- or over-estimate in recent years. The appropriate index for each equation is given in Table 2.

Except for the projections of value added in the primary and manufacturing sectors, which took account of the first difference of fitted values, the projections were carried out in this way. The influence of I^p and thus obtained projection results are illustrated in Figures 1-6 and Table 3. Table 4 presents the projections of macro-variables: the GNP growth rate was expected to be 7.4 per cent in 1972 and 9.5 per cent in 1973. The projection, as a whole, appears quite reasonable, as it indicates retardation of growth rate of GNP for 1972 due to lack of investment demand and slower growth of production in the social overhead and service sectors. It further shows recovery of the economy in 1973 due to a general improvement in economic activity.

Table 2

Trend Adjustment Indicators

Variable	I^p	Variable	I^p
C^p	0.999	M^k	0.976
C^g	1.048	M^d	0.978
I^a	1.075	M^x	0.985
I^m	0.973	M^f	1.040
I^o	0.996	V^o	0.8695
I^s	0.948	V^s	1.0349
I^v	0.803		

Table 3. Projection of Gross National Product

	1971			1972			1973		
	Priliminary Value	Composition (%)	Growth Rate(%)	Projected Value	Composition (%)	Growth Rate(%)	Projected Value	Composition (%)	Growth Rate(%)
Expenditure on GNP	1566.91	100.0	10.2	1682.32	100.0	7.4	1858.44	100.0	10.5
Consumption	1338.31	85.4	11.2	1456.96	86.6	8.9	1590.52	85.6	9.2
Investment	483.46	30.9	6.1	497.65	29.6	2.9	502.11	27.0	0.9
Fixed Investment	438.54	28.0	5.2	461.62	27.4	5.3	469.00	25.2	1.6
Exports	430.48	27.5	17.6	497.63	29.6	15.6	602.19	32.4	21.0
($)	(1622.00)			(1875.00)		-	(2269.00)		
Goods	299.90	19.1	28.1	380.85	22.6	27.0	482.23	25.9	26.6
($)	(1130.00)			(1435.00)			(1817.00)		
Imports	694.82	44.3	20.0	769.92	45.8	10.8	836.38	45.0	8.6
($)	(2618.00)			(2900.98)			(3151.39)		
Goods	579.00	37.0	21.1	622.89	37.0	7.4	672.89	36.2	8.0
($)	(2185.00)			(2346.99)			(2535.38)		
Net Imports	264.34	16.9	24.1	272.29	16.2	3.0	234.19	12.6	-14.0
($)	(996.00)			(1025.96)			(882.40)		
Statistical Discrepancy	9.48	0.6							
Industrial origin of GNP	1566.91	100.0	10.2	1684.57	100.00	7.5	1845.70	100.0	9.6
Agriculture, Fishery and Forestry	376.45	24.0	2.5	393.72	23.4	4.6	411.75	22.3	4.6
Mining and Manufacturing	471.17	30.1	18.3	535.52	31.8	13.7	610.85	33.1	14.1
Social Overhead	198.78	12.7	6.7	206.73	12.3	4.0	212.70	11.5	2.9
Service	518.26	33.1	12.6	570.86	33.9	10.1	642.22	34.8	12.5
Net factor income from R.O.W	2.25	0.1		-22.26	-1.3		-31.82	-1.7	

Table 4. Comparison of Fitted Values and Projected Values

	1971			1972		1973	
	Preliminary Value	Fitted Value	Projected Value	Fitted Value	Projected Value	Fitted Value	Projected Value
C	1338.31	1318.63	1319.45	1437.12	1456.96	1563.06	1590.52
C^p	1196.62	1187.43	1184.88	1300.61	1302.52	1419.83	1420.79
C^g	141.69	131.25	134.57	136.51	154.44	143.23	169.73
I	483.46	493.15	463.56	524.72	497.65	548.09	502.11
I^f	438.54	459.28	424.55	485.76	461.62	503.52	469.00
I^a	32.51	30.60	29.24	30.56	35.89	33.24	41.97
I^m	109.55	114.35	99.16	125.13	116.56	137.54	124.60
I^o	158.39	170.24	160.94	172.33	165.83	164.08	157.21
I^s	138.09	144.09	135.21	157.74	143.34	168.66	145.20
I^i	44.92	33.87	39.01	38.96	36.03	44.57	33.11
M^{cif}	635.45	616.29	594.36	696.15	692.10	763.10	747.66
M^k	181.91	168.87	155.35	186.00	188.64	189.46	187.70
M^d	191.83	188.03	181.98	216.86	208.90	244.91	230.63
M^x	131.37	131.80	129.48	168.07	165.00	213.49	206.42
M^f	49.66	46.91	46.87	53.71	58.05	62.16	69.83
V	1566.91	1554.16	1557.59	1688.40	1684.57	1859.95	1845.70
V^a	376.45	389.65	382.02	406.92	393.72	424.95	411.75
V^m	471 17	441.70	454.78	506.05	535.52	581.38	610.85
V^o	198.78	233.19	201.18	278.93	206.73	332.04	212.70
V^s	518.26	487.37	517.36	518.76	570.86	563.40	642.22

Figure 1. Gross National Product (Demand).

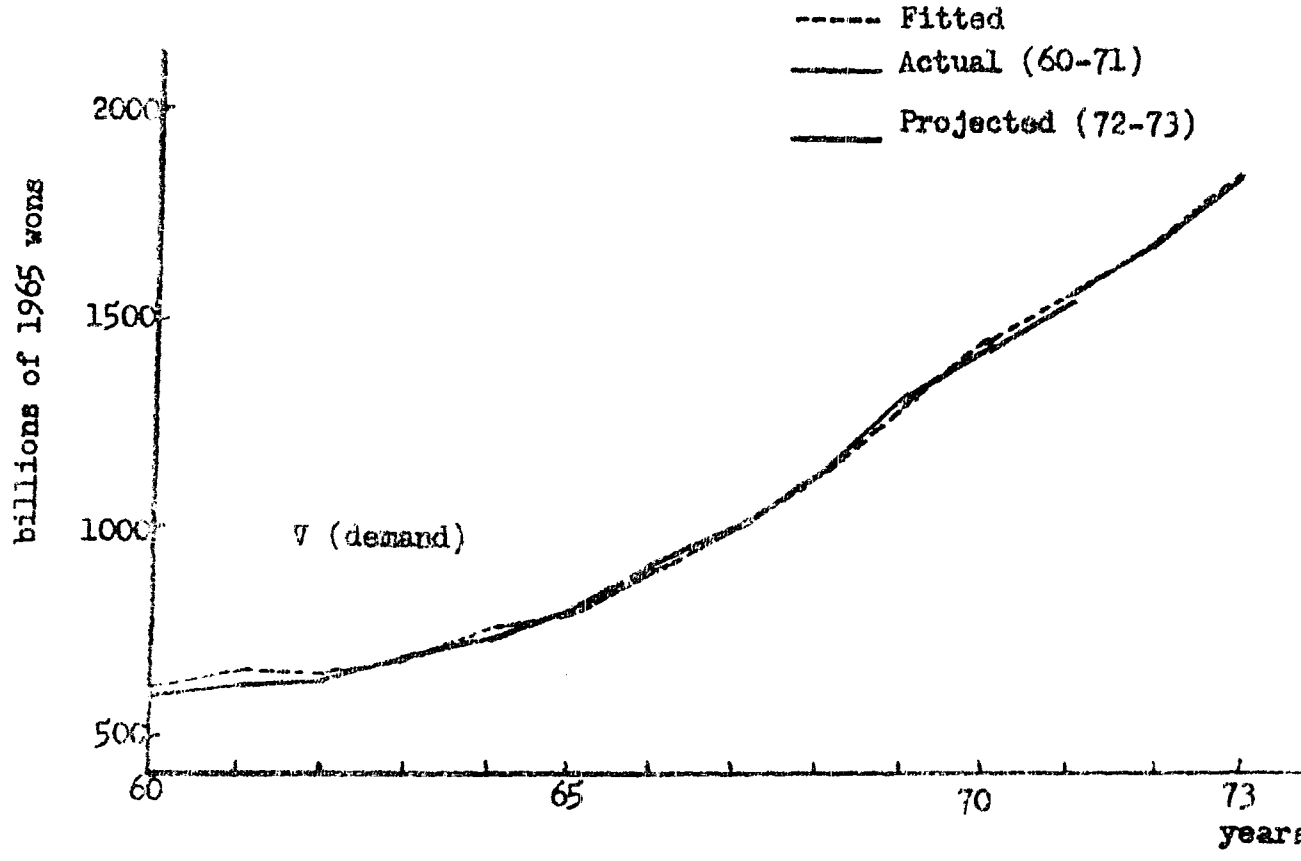


Figure 2. Gross National Product (Supply).

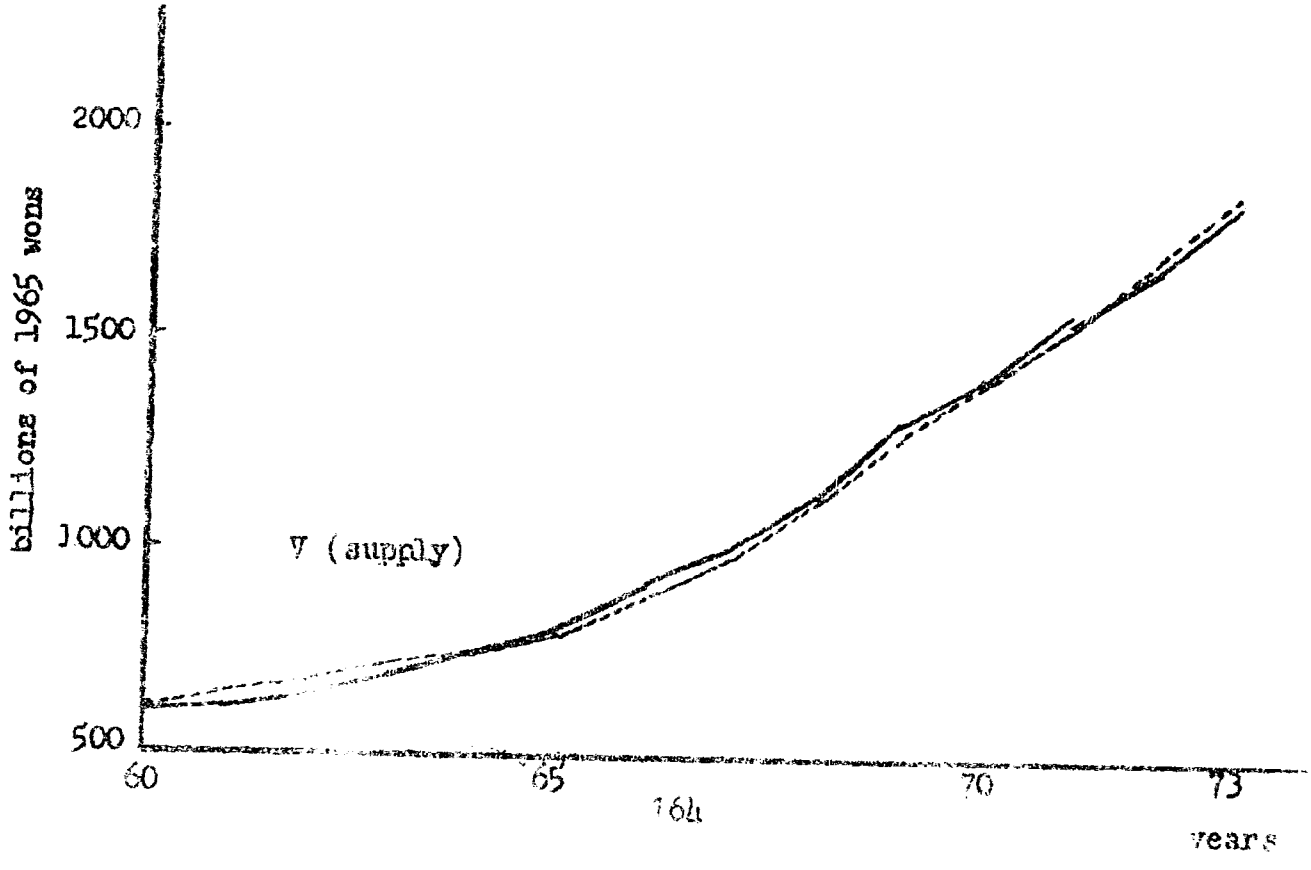


Figure 3. Gross Fixed Investment.

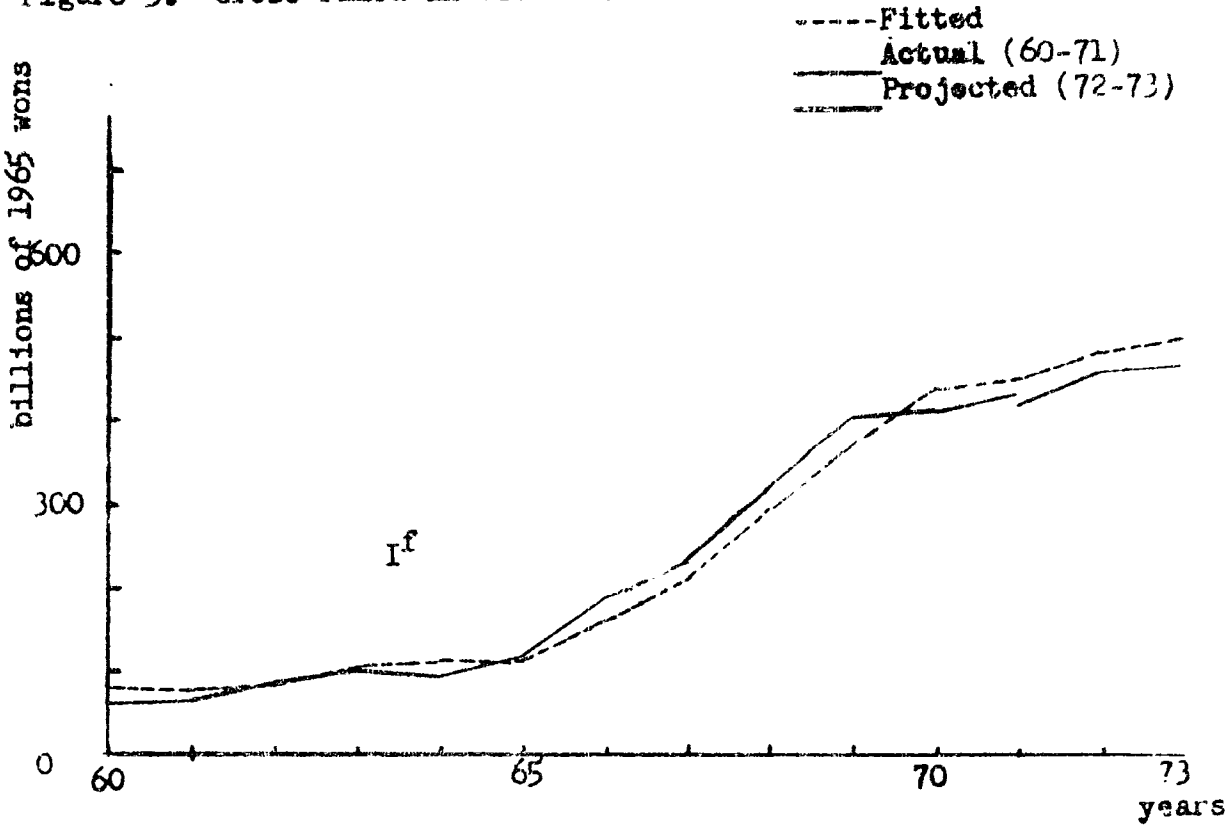


Figure $. Total Investment (Including increase in stock)

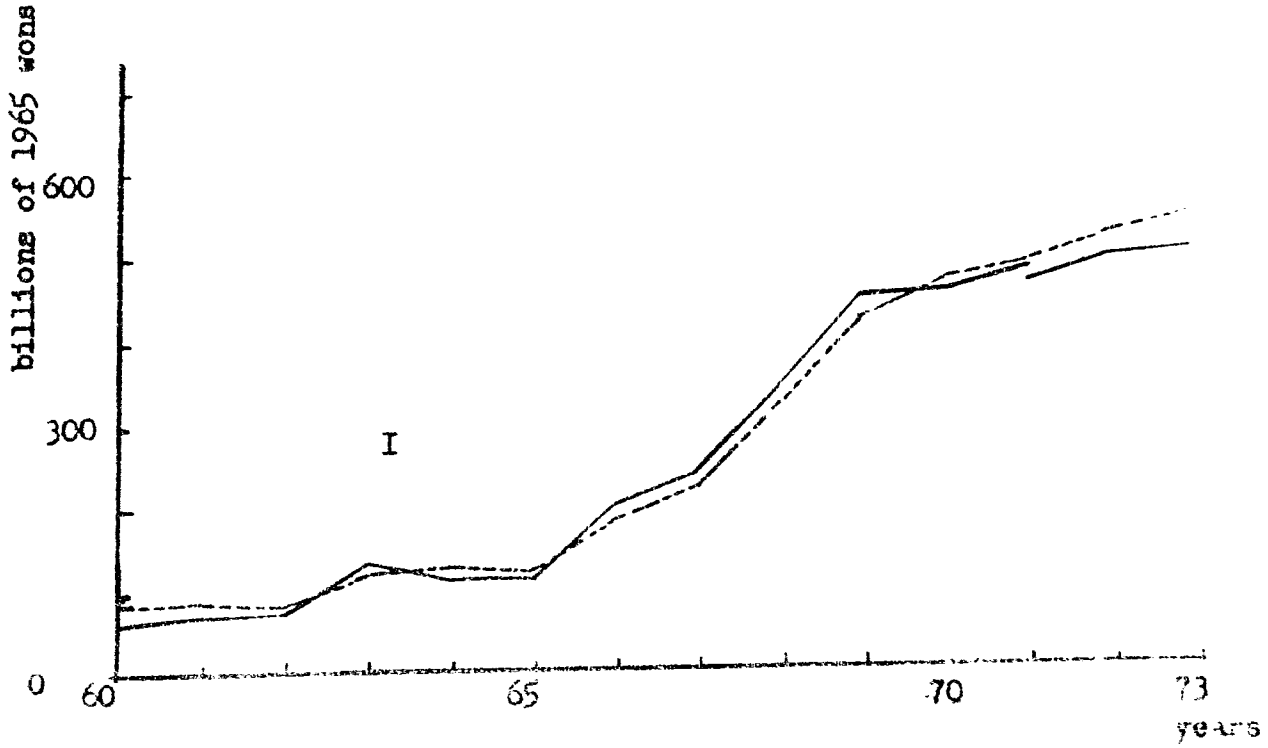


Figure 5. Consumption Expenditure.

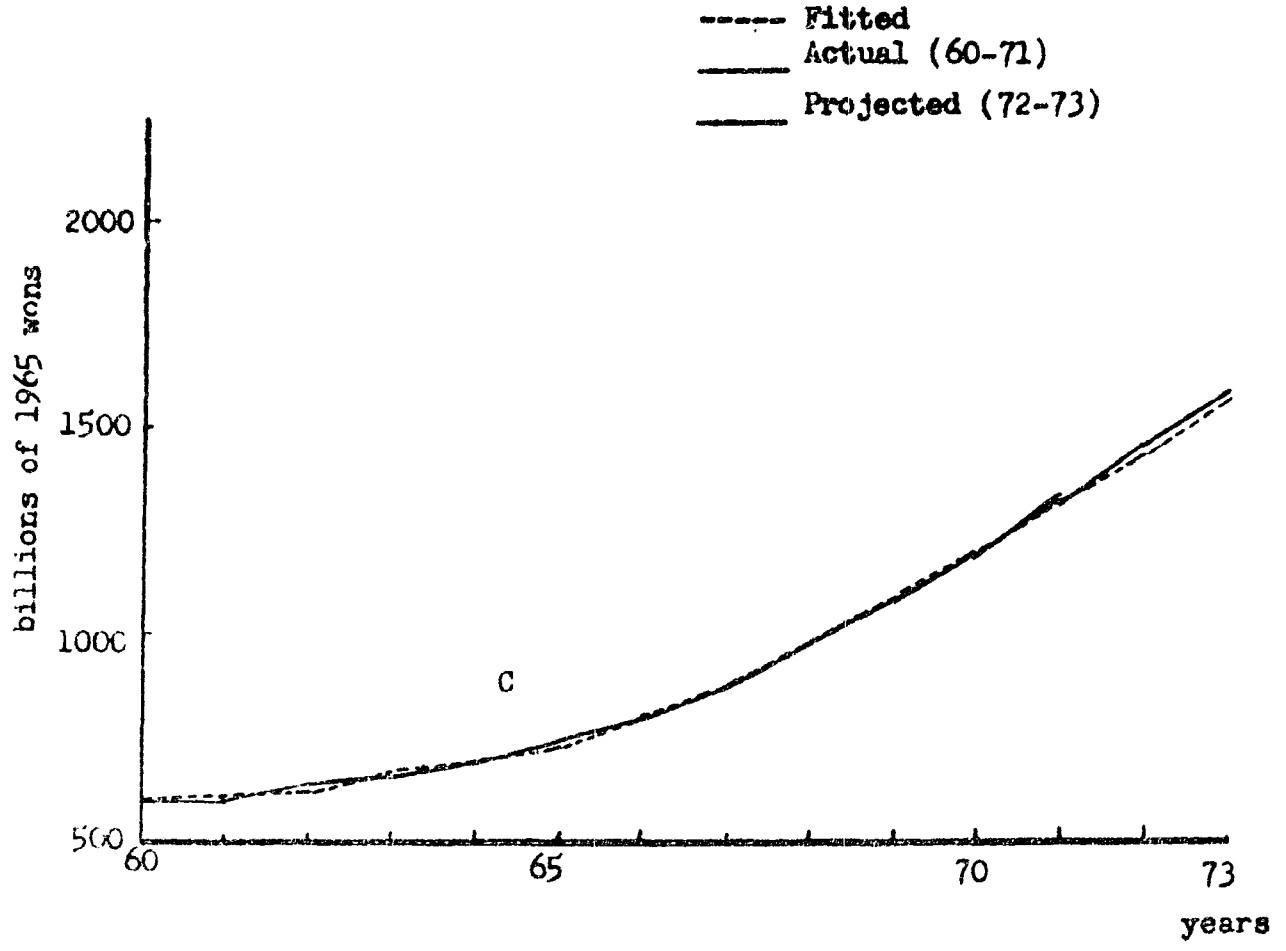
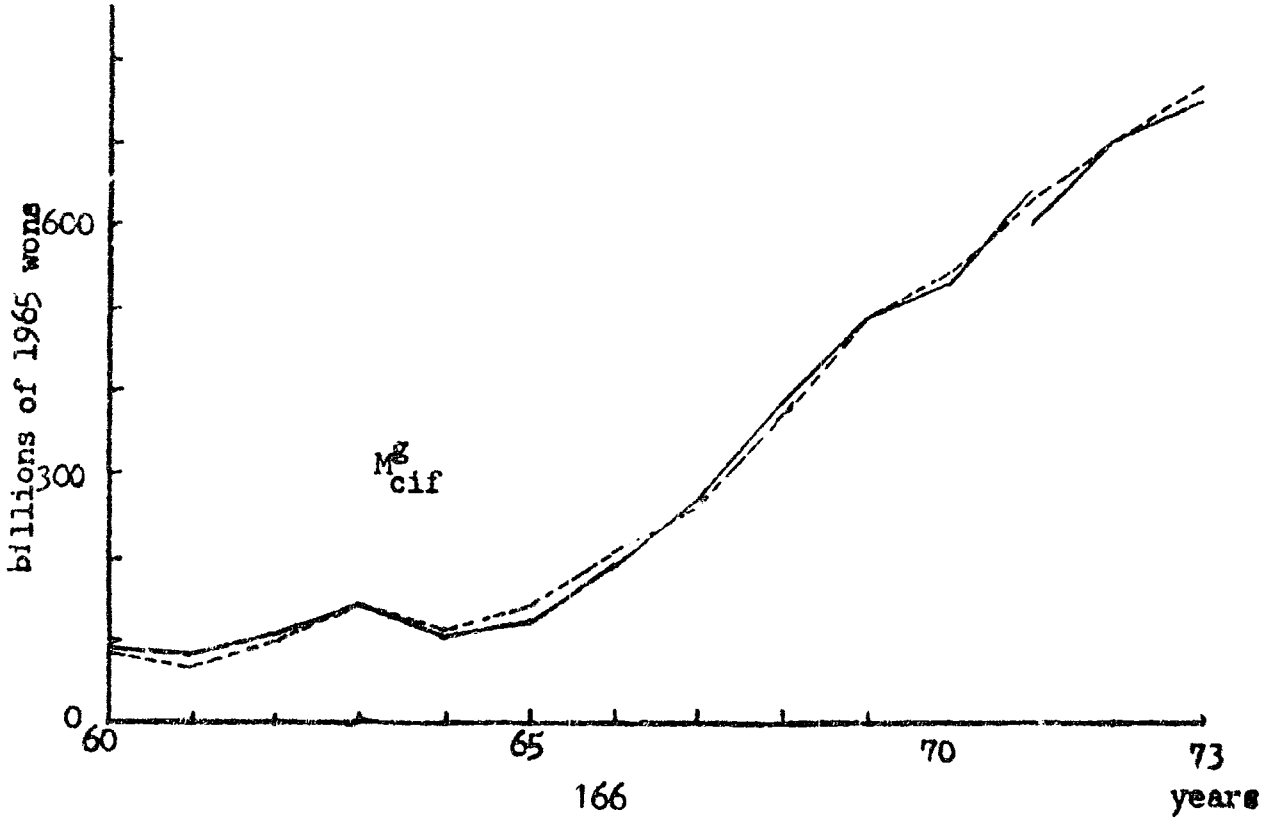


Figure 6. Imports of goods.



IV. CONCLUSION

This study has presented a macro-model for the analysis of the Korean economy. Based upon the model and with some forecasting techniquis employed, projections were made in order to view the future levels of economic activities in Korea. At this stage in the development of the model, however, they do not provide a comfortable base for normative inferences on policy issues. For the practical values of this model to be realized for planning purpose, the model has to be further developed along the lines of the suggestions made below.

First, a weakness of this model can be found in the fact that it hypothesizes a positive influence of financial variables without taking account of effects of financial intermediation on the behaviour of prices and various deflators. In order to improve the efficiency of the model, attempts will be worthwhile to adjust the model so that it contains a set of deflators and price equations which are interrelated with other structural equations. In this case, statistical equations which explain the behaviour of national account variables are to be estimated on the basis of values specified at current prices.

Second, it has to avoid the use of the money supply as a proxy variable for the liquid assets and the availability of financing for production and investment. It is desirable to disaggregate the money supply by sectors or to obtain relevant data to represent such sectoral allocation, since government financial policies are actually formulated to direct optimum resources allocation.

Third, the model has a limitation in the analysis and projection of the economy because of the exogenous treatment of many variables. Although it is not necessarily desirable to have a sophisticated system, some variables such as some important categories of exports of goods and services, imports of grains and services, and tax revenues are preferred to be expressed as functions of more basic economic variables.

Finally, it is also desirable to disaggregate private consumption expenditure by type of expenditures or even by sectors in view of long-term shifts in preferences and different consumption patterns among regions.

APPENDIX I. GROWTH OF CAPITAL STOCK, EMPLOYMENT, AND THE MONEY SUPPLY, AND THEIR CONTRIBUTION TO THE GROWTH OF THE ECONOMY.

The hypothesis of a Cobb-Douglas type production function for the Korean economy enables us to analyze factor contributions to growth in the past. This analysis is worthwhile as we can observe the productivity change resulted by a variation of factor proportion. The general growth equation is derived from a production function in which:

$$\frac{\Delta V}{V} = \lambda + \alpha_K \frac{\Delta K}{K} + \alpha_L \frac{\Delta L}{L} + \alpha_{MS} \frac{\Delta MS}{MS}$$

where λ is the coefficient for t; α_K, α_L and α_{MS} are output growth elasticities with respect to K, L and MS.

The average annual growth rates of factors and their contributions to growth are presented in Table 5-9.

In the primary sector, growth of the capital stock was the most contributing factor, explaining 94 per cent of the growth of production. Comparison of factor contributions during sub-periods indicates that the contribution of the capital stock is increasing while that of employment is decreasing. Growth the level of fertilizer input was found to be an important factor during the period 1957-1961.

52 per cent of growth of mining and manufacturing production is explained by the total productivity or residual factor. But this percentage is decreasing while those of other factors are increasing.

As expected, growth of social overhead production is mainly explained by the growth of the capital stock, especially during the latter half of the 1960's. Here again, a good deal of growth is not

explained by either capital stock, employment or financial availability.

Increases in capital stock were found not to be a significant factor in the growth of value added in the service sector. Rather, availability of financing is the most important factor, which is quite conceivable in view of the importance of working capital in trade. Employment gorwth also contributed to the growth of this sector significantly.

For the economy as a whole, it is found that the contribution of capital stock has been increasing which may reflect an increasing rate of utilization of capicity with the additional supply of other inputs. Assuming that the total productivity factor is explained proportionally to the relative importance of other factors, growth of the capital stock has contributed 41 per cent of the 8.3 per cent average annual growth of the economy during the sample period. Employment growth and an increase in the availability of financing meanwhile explained 18 per cent and 39 per cent of this economic growth.

Table 5: Average Annual Growth Rates (%) of V, K, L and Fe and Contributions of K, L, Fe and D^w to Growth (%); The Primary Sector.

		1957-1961	1961-1965	1965-1968	1968-1971	1957-1965	1965-1971	1957-1971
	$\Delta V^a/V^a$	3.883	3.791	2.013	4.400	3.838	3.200	3.564
	$\Delta K^a/K^a$	3.164	4.258	7.413	7.370	3.573	7.392	5.193
	$\Delta L^a/L^a$	0.744	0.232	-0.915	-1.075	0.487	-0.994	-0.151
	$\Delta Fe/Fe$	14.550	1.900	4.495	2.038	8.040	3.261	5.969
	ΔD^w	-18.90	0	25.99	25.99	-9.05	0	-5.08
a	$\widehat{\Delta V^a}/\widehat{V^a}$	2.605	2.843	3.840	5.157	2.638	4.498	3.426
b	$\alpha_K \cdot \Delta K^a/K^a$	1.965	2.644	4.603	4.577	2.219	4.590	3.225
c	$\alpha_L \cdot \Delta L^a/L^a$	0.232	0.072	-0.285	-0.335	0.152	-0.310	-0.0[illegible]
d	$\alpha_{Fe} \cdot \Delta Fe/Fe$	0.975	0.127	0.301	0.136	0.539	0.218	0.40[illegible]
e	$\lambda \cdot \Delta D^w$	-0.567	0	-0.779	0.779	-0.272	0	-0.15[illegible]
	b/a	75.43	93.00	119.87	88.75	84.12	102.05	94.13
	c/a	8.91	2.53	-7.42	-6.50	5.76	-6.89	-1.37
	d/a	37.43	4.47	7.84	2.64	20.43	4.85	11.68
	e/a	-21.77	0	-20.29	15.11	-10.31	0	-4.44

Note: $\alpha_k = 0.621$ $\alpha_L = 0.312$ $\alpha_{Fe} = 0.067$ $\lambda = 0.03$

Average Annual Growth Rates (%) of V, K, L and MS, and Contributions of K, L, MS and t to Growth (%); The Mining and Manufacturing Sector.

		1957-1961	1961-1965	1965-1968	1968-1971	1957-1965	1965-1971	1957-1971
	$\Delta V^m/V^m$	7.301	14.505	21.078	16.545	10.845	20.032	14.693
	$\Delta K^m/K^m$	2.678	2.430	7.578	8.636	2.555	8.106	4.898
	$\Delta L^m/L^m$	3.269	14.011	13.755	2.025	8.506	7.730	8.173
	$\Delta MS/MS$	17.362	0.658	26.290	21.003	8.691	23.618	14.854
a	$\widehat{\Delta V^m}/\widehat{V^m}$	12.195	12.242	18.893	16.217	12.146	17.514	14.393
b	$\alpha_k \cdot \Delta K^m/K^m$	1.717	1.358	4.857	5.536	1.638	5.196	3.140
c	$\alpha_L \cdot \Delta L^m/L^m$	0.739	3.166	3.109	0.458	1.922	1.747	1.847
d	$\alpha_{MS} \cdot \Delta MS/MS$	2.309	0.088	3.497	2.793	1.156	3.141	1.976
e	t	7.43	7.43	7.43	7.43	7.43	7.43	7.43
	b/a	14.08	12.73	25.71	34.14	13.49	29.67	21.82
	c/a	6.06	25.86	16.46	2.82	15.82	9.97	12.83
	d/a	18.93	0.72	18.51	17.22	9.52	17.93	13.73
	e/a	60.93	60.69	39.33	45.82	61.17	42.42	51.62
	b/(b+c+d)	36.03	32.38	42.37	63.00	34.73	51.53	45.10
	c/(b+c+d)	15.51	65.79	27.12	5.21	40.75	17.32	26.53
	d/(b+c+d)	48.46	1.83	30.51	31.79	24.51	31.15	28.38

Note: $\alpha_k = 0.641$ $\alpha_L = 0.226$ $\alpha_{MS} = 0.133$

Table 7: Average Annual Growth Rates (%) of V, K, L and MS and Contributions of K, L, MS and t to Growth (%); The Social Overhead Sector.

		1957-1961	1961-1965	1965-1968	1968-1971	1957-1965	1965-1971	1957-1971
	$\Delta V^o/V^o$	8.444	15.660	22.890	15.209	11.994	18.981	14.940
	$\Delta K^o/K^o$	2.525	4.674	8.424	17.867	3.595	13.047	7.545
	$\Delta L^o/L^o$	11.088	7.432	6.984	7.509	9.245	7.247	8.384
	$\Delta MS/MS$	17.362	0.658	26.290	21.003	8.691	23.618	14.854
a	$\widehat{\Delta V^o}/\widehat{V^o}$	11.839	12.415	16.908	24.687	12.713	20.713	15.695
b	$\alpha_K \cdot \Delta K^o/K^o$	2.141	3.964	7.144	15.151	3.049	11.064	6.398
c	$\alpha_L \cdot \Delta L^o/L^o$	1.098	0.736	0.691	0.743	0.915	0.717	0.830
d	$\alpha_{MS} \cdot \Delta MS/MS$	0.920	0.035	1.393	1.113	0.461	1.252	0.787
e	t	7.68	7.68	7.68	7.68	7.68	7.68	7.68
	b/a	18.18	31.93	42.25	61.37	25.19	53.42	40.76
	c/a	9.27	5.93	4.09	3.01	7.56	3.46	5.29
	d/a	7.77	0.28	8.24	4.51	3.81	6.04	5.01
	e/a	64.87	61.86	45.42	31.11	63.44	37.08	48.93
	b/(b+c+d)	51.48	83.72	77.42	89.09	68.90	84.89	79.83
	c/(b+c+d)	26.40	15.54	7.49	4.37	20.68	5.50	10.36
	d/(b+c+d)	22.12	0.74	15.10	6.54	10.42	9.61	9.82

Note: $\alpha_k = 0.848$ $\alpha_L = 0.099$ $\alpha_{MS} = 0.053$

Table 8: Average Annual Growth Rates (%) of V, K, L and MS and Contributions of K, L, MS to Growth (%); The Service Sector

		1957-1961	1961-1965	1965-1968	1968-1971	1957-1965	1965-1971	1957-1971
	$\Delta V^S/V^S$	2.740	5.570	12.076	12.436	4.145	12.256	7.547
	$\Delta K^S/K^S$	0.388	0.700	1.472	3.890	0.543	2.673	1.451
	$\Delta L^S/L^S$	4.616	5.335	5.159	4.805	4.975	4.982	4.978
	$\Delta MS/MS$	17.362	0.658	26.290	21.003	8.691	23.618	14.854
a	$\widehat{\Delta V^S}/\widehat{V^S}$	8.508	2.589	12.319	10.701	5.429	11.497	7.940
b	$\alpha_K \cdot \Delta K^S/K^S$	0.038	0.149	0.314	0.829	0.116	0.569	0.309
c	$\alpha_L \cdot \Delta L^S/L^S$	1.897	2.193	2.120	1.975	2.045	2.048	2.046
d	$\alpha_{MS} \cdot \Delta MS/MS$	6.528	0.247	9.885	7.897	3.268	8.880	5.585
	b/a	0.98	5.76	2.55	7.75	2.14	4.95	3.89
	c/a	22.30	84.70	17.21	18.46	37.67	17.81	25.77
	d/a	76.73	9.54	80.24	73.80	60.20	77.24	70.34

Note: $\alpha_K = 0.213$ $\alpha_L = 0.411$ $\alpha_{MS} = 0.376$

Table 9: Average Annual Growth Rates (%) of V and Contribution of K, L, MS, Fe, D^W and to Growth (%); The Korean Economy.

		1957-1961	1961-1965	1965-1968	1968-1971	1957-1965	1965-1971	1957-1971
	$\Delta V/V$	4.222	7.049	11.455	12.291	5.627	11.871	8.259
	V^a/V	43.56	40.22	33.97	26.31	41.89	30.14	36.86
	V^m/V	14.59	18.03	22.76	28.23	16.31	25.50	20.24
	V^o/V	6.18	7.76	10.47	12.97	6.97	11.72	9.01
	V^s/V	35.67	33.99	32.80	32.49	34.83	32.64	33.89
a	$\Delta\hat{V}/\hat{V}$	6.680	5.263	11.415	12.614	5.821	12.003	8.281
b	K	1.268	1.703	3.520	5.001	1.450	4.191	2.505
c	L	0.953	1.402	1.379	0.779	1.153	1.105	1.125
d	MS	2.722	0.171	4.184	3.499	1.359	3.846	2.364
e	Fe	0.425	0.051	0.102	0.036	0.226	0.066	0.147
f	D^W	-0.247	0	-0.265	0.205	-0.114	0	-0.056
g	t	1.559	1.936	2.495	3.094	1.747	2.795	2.196
	b/a	18.98	32.36	30.84	39.65	24.91	34.92	30.25
	c/a	14.27	26.64	12.08	6.18	19.81	9.21	13.59
	d/a	40.75	3.25	36.65	27.74	23.35	32.04	28.55
	e/a	6.36	0.97	0.89	0.29	3.88	0.55	1.78
	f/a	-3.70	0	-2.32	1.63	-1.96	0	-0.68
	b/(b+c+d+e+f)	24.76	51.19	39.46	52.53	35.59	45.51	41.17
	c/(b+c+d+e+f)	18.61	42.14	15.46	8.18	28.30	12.00	18.49
	d/(b+c+d+e+f)	53.15	5.14	46.91	36.75	33.36	41.77	38.85
	e/(b+c+d+e+f)	8.30	1.53	1.14	0.38	5.55	0.72	2.42
	f/(b+c+d+e+f)	-4.82	0	-2.97	2.15	-2.80	0	-0.92

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A SIMPLE PROJECTION MODEL OF INDIRECT TAX REVENUE

Wan-Soon Kim

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PREFACE

This paper is one in the series of continuing KDI research works which is desired to aid in the formulation of sound public policies and to promote public understanding of major issues of the Korean Economy.

In this paper, Wan-Soon Kim goes beyond the usual formulation in which taxes are dealt with in fairly aggregate form and explained by a simple relationship to income. The author attempts to disaggregate indirect taxes and to define the tax yield as a function of both tax base and tax rate variables. After obtaining the parameters of the model, he estimates the yield of indirect tax for the years 1972 and 1973.

The interpretations and conclusions in this paper are those of the author and do not represent the views of the Korea Development Institute. Finally, I would like to extend our appreciation to those within the Institute who have participated in these endeavours.

Mahn Je Kim
President

A SIMPLE PROJECTION MODEL OF INDIRECT TAX REVENUE

by

van-Soon Kim*

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I. INTRODUCTION

In economic models, taxes are usually dealt with in fairly aggregated form and explained by a simple relationship, for example, to income. Additionally, previous estimates of income-elasticities have been made only for constant tax rates. An attempt is made in this paper to disaggregate indirect taxes and to define the tax yield as a function of both tax base and tax rate variables. Section II reviews briefly Korea's indirect tax structure. In Section III, an appropriate indirect tax function is formulated and the determinants of selected indirect tax items are identified. Empirical analyses follow immediately. For the sake of exposition, however, they are divided into two parts. While, in Section III, the peculiarities of the indirect tax items under question are explained with frequent references to their numerical estimates that follow, Section IV makes general statistical observations on the computed equations. In the latter parts of the paper, the parameters of the model are obtained and the yield of the eight categories of indirect tax is projected for the years 1972 and 1973 by using the estimated equations.

II. INDIRECT TAX STRUCTURE

In the 1960's, with the change in government, the real momentum of economic growth began in Korea. This was also visible in Korea's effort to boost its public saving. Particularly, as a result of the tax reform enacted in 1967, which included changes in rates and in coverage, the yield and the composition of taxes have undergone a major transformation. There were other factors which contributed significantly to the

Table A: Tax Yield, 1965-1971

(in millions of won)

	1965 Tax yield	Share %	1966 Tax yield	Share %	1967 Tax yield	Share %	1968 Tax yield	Share %
Direct tax	18,920	32.6	33,801	35.5	51,099	37.0	77,702	36.9
Indirect tax	21,892	37.8	34,234	35.9	49,338	35.7	75,669	35.0
Business activity tax	4,360	7.5	7,282	7.6	11,550	8.4	17,500	8.3
Commodity tax	7,021	12.1	10,346	10.8	15,372	11.1	22,223	10.6
Textile products tax	-	-	-	-	-	-	-	-
Liquor tax	3,767	6.5	6,342	6.7	8,105	5.9	11,147	5.3
Petroleum products tax	3,160	5.5	3,656	3.8	4,631	3.3	11,366	5.4
Admission tax	695	1.2	1,057	1.1	1,643	1.2	2,236	1.1
Transportation tax	1,241	2.1	3,324	3.5	5,054	3.7	7,096	3.4
Electricity & gas tax	1,638	2.8	2,207	2.4	2,936	2.1	4,069	1.9
Others	10	0.0	21	0.0	46	0.0	33	0.0
Indirect tax(including)	38,337	66.1	59,737	62.7	84,751	61.3	129,950	61.8
Customs	12,847	22.1	18,003	18.9	25,413	18.4	37,881	18.0
Monopoly profits	3,598	6.2	7,500	7.9	10,000	7.2	16,400	7.8
Stamp revenues	738	1.3	1,775	1.8	2,312	1.7	2,677	1.3
Total tax revenue	57,995	100.0	95,313	100.0	138,162	100.0	210,329	100.0

Source: Statistical Yearbook of National Tax

(continued)	1969 Tax yield	Share %	1970 Tax yield	Share %	1971 Tax yield	Share %	Average annual growth rate 1965-71 (%)
Direct tax	110,423	38.5	138,605	37.8	178,456	40.0	45
Indirect tax	103,769	36.2	142,496	38.9	172,630	38.7	41
Business activity tax	23,031	8.0	31,022	8.5	37,935	8.5	43
Commodity tax	30,798	10.7	31,692	8.6	34,891	7.8	30
Textile products tax	-	-	10,689	2.9	10,092	2.3	-
Liquor tax	16,129	5.6	21,741	5.9	27,650	6.2	39
Petroleum products tax	14,903	5.2	21,261	5.8	31,757	7.1	47
Admission tax	3.191	1.1	4,620	1.3	4,920	1.1	39
Transportation tax	10,326	3.6	14,341	3.9	17,148	3.8	55
Electricity & gas tax	5,315	1.8	7,049	1.9	8,176	1.8	28
Others	76	0.0	80	0.0	70	0.0	38
Indirect tax(including)	172,743	60.2	224,343	61.2	263,681	59.1	38
Customs	44,724	15.6	51,774	14.1	53,051	11.9	27
Monopoly profits	24,250	8.4	30,100	8.2	38,000	8.5	47
Stamp revenues	3,626	1.3	3,861	1.0	4,264	1.0	34
Total tax revenue	286,792	100.0	366,809	100.0	446,401	100.0	40

impressive revenue gains: the creation of the National Tax Administration in 1966, the discovery of hidden and previously untapped tax resources, and a rapid rise in income. As a whole, one cannot fail to observe the striking performance of Korea's government saving through increased tax revenues. As Table A indicates, between 1965 and 1971, the central government's tax revenues registered an annual growth rate of 40 percent.

The growth of indirect taxes was similarly impressive. Transportation, liquor, and commodity tax revenues more than doubled from 1967 to 1971. The 1967 tax reform provided for rate adjustments on alcoholic beverages, rate increases, and broadening of the list of taxable items under the commodity tax. Petroleum products taxes increased by eight times from 1967 to 1971, reflecting major adjustments in tax rates and the growth in the number of motor vehicles.

Indirect taxes constitute a relatively large share of total national tax revenue. As is shown in Table A, the share of indirect taxes[1], including business activity taxes, custom duties, and monopoly profits (largely from the sale of cigarettes), in national tax revenue is very high (66 percent in 1965), although it has been reduced sharply in 1971. For the individual items of indirect tax, the following picture emerges. A large proportion of indirect tax revenue comes from taxes on imports, cigarettes, business activity, commodities, and liquor. Whereas in

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[1] For the sake of consistency with the "official" definition of indirect tax revenue, custom duties and monopoly profits are excluded. However, business activity is here subsumed under indirect tax revenue. Also indirect taxes collected by the local governments are excluded.

absolute figures the yield from the individual items has greatly increased, the situation becomes different for the relative shares in total indirect tax revenue of several items. Custom duties, which accounted for more than 22 percent of national tax revenue in 1965, suffered a significant reduction in 1971 by about 10 percentage points. Similarly, during the same period, the share of commodity taxes decreased from 12 percent to roughly 8 percent. A wide variety of fiscal concessions offered to export and import-substituting industries accounts for these changes, despite upward adjustments in their weighted average tax rates (see Appendix Table I).

III. INDIRECT TAX FUNCTION AND DETERMINANTS OF INDIRECT TAX ITEMS

We start with the construction of an appropriate tax function at a general level and will modify each estimating equations according to the peculiarities of the indirect tax items under question. The hypothesis is that indirect tax revenues are a function of both the tax base and the tax rate. Thus, the indirect tax function may be written as

$$T_t = F(R_t, Y_t)$$

where

T = yield of an indirect tax

R = tax rate

Y = tax base

The functional form we have chosen in order to facilitate analysis is a linear one. Thus, we may write

$$T_t = \alpha_0 + \alpha_1 R_t + \alpha_2 Y_t.$$

Non-agricultural GNP, private consumption expenditures, and value added in manufacturing are vicariously introduced as proxy variables for the actual tax base. In order to reflect the tax burden under the "stagflationary" conditions from which the Korean economy is now suffering, both current tax revenues and income variables are measured at 1965 prices.

Tax rate changes have been allowed for as far as possible. As tax rates vary according to different categories of taxable objects, this has necessitated a computation of weighted average tax rates for individual items, the proportions of the 1970 tax yield [2] being used as weights, which may not always capture accurately the precise effects of a rate change on tax yield. Because of the high correlation between income and rate changes, however, the absence of a tax rate variable in explanatory equations would have led to an unreasonably high estimate of the elasticity of tax yield with respect to income. [3]

1. Business activity tax

Since the business activity tax is a multistage tax, based on the gross sales of business enterprises, it is here defined to be subsumed under the categories of indirect tax revenue. The scope of the business activity tax is broken down into 20 enterprises, which are maintained

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[2] The 1970 tax yield is used as weights, because the yield data in the early years are strongly affected by institutional changes.

[3] Duesenberry et al. [1, p. 534]

at a relatively low schedule of rates. In 1971, the statutory rate ranged from 0.36 percent on insurance companies to 2.4 percent on restaurant and entertainment businesses. In deriving an appropriate tax function, non-agricultural GNP at 1965 prices has been introduced as a proxy variable for the actual tax base. Experimentation with producers' shipments as a proxy variable for the tax base and with various time lags has been of little help in explaining tax receipts. We write the estimating equation for determining the business activity tax as

$$T(BA) = \alpha_0 + \alpha_1 R(BA) + \alpha_2 GNPNA \quad \ldots\ldots\ldots\ldots \quad (1)$$

where,

T(BA) = revenue from business activity at 1965 prices, millions of won,

R(BA) = weighted average tax rate on gross sales, fraction, and

GNPNA = non-agricultural GNP at 1965 prices, millions of won.

2. Commodity and Textile Products Taxes

Korea levies a commodity tax, which covers about 70 categories of imported and locally manufactured and processed commodities. *Ad valorem* rates in 1971 ranged from a minimum of 2 percent to a maximum of 100 percent on the value of shipments from the factory.

Textile products which had been subject to the system of commodity taxation became separate sources for government tax revenue in 1970. Thus, in deriving appropriate revenue functions both for commodity and textile products taxes, about 20 textile items have been taken out from

the previous list of taxable commodities. Ideally, further, the most realistic approach should have been to isolate luxuries and semi-luxuries from taxable commodities. The data paucity has been the chief limitation on the construction of another estimating equation.

Contrary to our a priori reasoning, experimentation with personal consumption expenditure as a proxy variable both for commodity and textile products tax bases has had weaker explanatory power compared to non-agricultural GNP. We write the estimating equations for commodity and textile products taxes as

$$T(C) = \alpha_0 + \alpha_1 R(C) + \alpha_2 GNPNA \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

where,

T(C) = revenue from commodity at 1965 prices, millions of won,

R(C) = weighted average tax rate on commodities, fraction,

$$T(TP) = \alpha_0 + \alpha_1 R(TP) + \alpha_2 GNPNA \quad \ldots\ldots\ldots\ldots \quad (3)$$

where,

T(TP) = revenue from textile products at 1965 prices, millions of won,

R(TP) = weighted average tax rate on textile products, fraction.

3. Liquor Tax

The three major categories of alcoholic beverages are beer, distilled spirits, and rice wine. At present, liquor taxes are levied on the manufacturer based on liquors shipped, ranging from a minimum of 10 percent on takjn to a maximum of 120 percent on beer.

Since the liquor tax is not entirely placed on an ad valorem basis, it is likely that some errors have been built in as weighted average tax rates are computed by converting specific rates into ad valorem equivalents. As will be shown later in detail, it is interesting to observe that the coefficient for the tax rate variable is negative, though the rate elasticity being less than unity. A negative coefficient implies that tax receipts would fall as rate increases. This is plausible as tax revenues from price- and income- elastic beer account for about half of liquor tax collections.

Unlike commodity tax, private consumption expenditure rather than non-agricultural GNP has improved the explanatory power of the estimating equation. We write the estimating equation for liquor tax as

$$T(L) = \alpha_0 + \alpha_1 R(L) + \alpha_2 PC \quad \ldots\ldots\ldots\ldots\ldots \quad (4)$$

where,

T(L) = revenue from liquor at 1965 prices,

R(L) = weighted average tax rate on liquor, fraction (ad valorem) and

PC = private consumption expenditure at 1965 prices, millions of won.

4. Petroleum Products Tax

Revenues from the taxation of petroleum products (six categories) are affected by the Government price policy for these commodities, the tax rates, and the composition of their consumption. The statutory rate in 1970 ranged from 10 percent on Bunker C. Oil to heavier taxes on

gasoline - 200 percent. In experimenting with alternative tax bases, only value added in manufacturing has increased the explanatory power of the estimating equation. Similar to the cases of liquor and textile products taxes, the coefficient on tax rate has become negative. We write the estimating equation as

$$T(PP) = \alpha_0 + \alpha_1 R(PP) + \alpha_2 VM \quad \ldots\ldots\ldots\ldots\ldots \quad (5)$$

where,

T(PP) = revenue from petroleum products at 1965 prices, millions of won,

R(PP) = weighted average tax rate on petroleum products, fraction,

VM = value added in manufacturing at 1965 prices.

5. Admission, Transportation, and Electricity and Gas Taxes

Non-agricultural GNP has been used as an explanatory variable along with tax rates in deriving appropriate tax functions both for admission and transportation taxes. Experimentation with alternative tax bases such as admission fees and passanger fares has not given help in explaining variations in tax receipts. Logically, value added in the electricity and gas industries has been introduced as a proxy variable for the electricity and gas tax base.

Of all the rate elasticities, the one for the admission tax has exceeded unity by a substantial amount. With a positive rate coefficient, this implies that modest rate increases might produce additional tax receipts from admission. The rate variable has been eliminated in the estimating equation for electricity and gas tax, as it has been

unchanged at 15 percent throughout the period. We write the estimating equations for admission, transportation, and electricity and gas taxes as

$$T(A) = \alpha_0 + \alpha_1 R(A) + \alpha_2 GNPNA \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

where,

T(A) = revenue from admission at 1965 prices, millions of won,

R(A) = weighted average tax rate on admission, fraction.

$$T(TR) = \alpha_0 + \alpha_1 R(TR) + \alpha_2 GNPNA \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

where,

T(TR) = revenue from transportation at 1965 prices, millions of won

R(TR) = weighted average tax rate on transportation, fraction.

$$T(EG) = \alpha_0 + \alpha_1 VEG \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

where,

T(EG) = revenue from electricity and gas at 1965 prices,

VEG = value added in electricity and gas at 1965 prices.

IV STATISTICAL DATA AND NUMERICAL ESTIMATES

The major source of statistical information for tax yields required to estimate the equations is The Statistical Yearbook of National Tax (National Tax Administration). Figures for tax bases are obtained from Statistical Data for Economic Analysis, 1971 (Bank of Korea), which provides the data on national accounts. The basic information on statutory tax rates required to compute weighted average tax rates comes from Tax Law Compendium, 1972.

The parameters of equations (1) through (8) have been estimated on the basis of semi-annual, seasonally unadjusted data covering the period 1965-1971. As indicated earlier, current tax revenues have been measured at 1965 prices. In view of the fact that some portions of indirect taxes have been collected in yearly advance since 1969 as actual tax receipts seem to be falling short of the target amounts, adjustments are made to tax yield data to reflect properly current tax liabilities (see Appendix Table II). The estimation method employed is single equation least squares. The regression results are as follows:

The figures in parentheses below the regression coefficients are t-statistics. $\bar{R}^2$ and D-W are the coefficient of multiple determination corrected for degrees of freedom and the Durbin-Watson statistics, respectively. The coefficients of almost all explanatory variables are significant at the 5 percent level, and many of them even at the 1% level. Exceptions are the coefficients on the rate variables for the equations determining petroleum products and business activity taxes.

From a statistical point of view the empirical results seem to be satisfactory. More precisely, the proportion of total variation explained by the hypothesis, as measured by the value of $\bar{R}^2$, is very high.

From tables of the probability distribution of the statistic D-W it appears that the calculated values are within the critical limits at the 5% significant level in all cases except the equations determining the business activity and commodity tax revenues. The computed values of the Durbin-Watson statistic for the relationship (1)

and (2) seem to indicate the presence of negative autocorrelations which we have not attempted to reduce by applying available statistical devices.

The computed equations are as follows:

$$T(BA) = \underset{(-3.165)}{-8147.07} + \underset{(1.360)}{4540.97}R(BA) + \underset{(22.445)}{0.0273}\,GNPNA \quad \ldots\ldots\ldots\ldots \quad (1)$$

$$\bar{R}^2 = 0.989 \qquad D\text{-}W = 3.180$$

$$T(C) = \underset{(-8.689)}{-6426.722} + \underset{(1.973)}{116.919}R(C) + \underset{(8.777)}{0.0242}GNPNA \quad \ldots\ldots\ldots\ldots \quad (2)$$

$$\bar{R}^2 = 0.975 \qquad D\text{-}W = 3.062$$

$$T(TP) = \underset{(3.422)}{1345.647} - \underset{(-4.357)}{169.516}R(TP) + \underset{(9.331)}{0.0102}GNPNA \quad \ldots\ldots\ldots\ldots \quad (3)$$

$$\bar{R}^2 = 0.896 \qquad D\text{-}W = 2.808$$

$$T(L) = \underset{(-10.966)}{-5164.36} - \underset{(-2.075)}{17.224}R(L) + \underset{(18.997)}{0.0239}PC \quad \ldots\ldots\ldots\ldots \quad (4)$$

$$\bar{R}^2 = 0.977 \qquad D\text{-}W = 2.074$$

$$T(PP) = \underset{(-2.877)}{-3719.338} - \underset{(-0.067)}{1.483}R(PP) + \underset{(5.678)}{0.0686}VM \quad \ldots\ldots\ldots\ldots \quad (5)$$

$$\bar{R}^2 = 0.888 \qquad D\text{-}W = 2.146$$

$$T(A) = \underset{(-2.404)}{-1768.453} + \underset{(1.721)}{55.298}R(A) + \underset{(8.332)}{0.00313}GNPNA \quad \ldots\ldots\ldots\ldots \quad (6)$$

$$\bar{R}^2 = 0.949 \qquad D\text{-}W = 1.413$$

$$T(TR) = \underset{(-9.325)}{-2936.29} + \underset{(2.113)}{53.856}R(TR) + \underset{(22.454)}{0.0128}GNPNA \quad \ldots\ldots\ldots\ldots \quad (7)$$

$$\bar{R}^2 = 0.983 \qquad D\text{-}W = 2.346$$

$$T(EG) = \underset{(0.154)}{25.056} + \underset{(10.125)}{0.146}VEG \quad \ldots\ldots\ldots\ldots \quad (8)$$

$$\bar{R}^2 = 0.890 \qquad D\text{-}W = 2.433$$

As was pointed out earlier, the form of the estimated equations (1) through (8) were chosen after several experiments with alternative tax bases and various time lags. As summarized in Table B,

we have found that yield elasticities with respect to income are all statistically significant at the 5 percent level. Furthermore, they exceed unity by a substantial amount, except for the one for the electricity and gas tax. In the case of liquor, the yield elasticity with respect to personal consumption expenditure is strikingly sensitive.

On the basis of the empirical results, we are inclined to believe that yield elasticities with respect to tax rate are generally low and/or are statistically insignificant at the 5 percent level. The rate elasticity exceeds unity only in the case of textile products, this being statistically significant. Although the rate elasticity for the admission tax is quite high, it is statistically significant at the 10 percent level.

V. PROJECTIONS

An attempt has been made to forecast indirect tax revenues by items for the years 1972 and 1973, using the estimated equations. For the values of predetermined variables used in the forecast, we have relied upon the predicted values given by Dr. Song's quarterly model.[3] The 1972 tax rates are actual, and assumed to continue unchanged throughout 1973. Therefore, errors in forecasting income and price (in Dr. Song's Model) may be reflected in estimates of many of the indirect tax items, since tax-base-surrogates are important explanatory variables in their estimating equations.

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[3] Song, [6, p.__].

Table B: Yield Elasticities with respect to Tax Base and Tax Rate

Variables / Items	Tax Base				Tax Rate
	GNPNA	PC	VM	VEG	
Business activity tax	1.602*				0.569
Commodity tax	1.543*				0.460*
Textile products Tax	1.520*				-1.013*
Liquor tax		2.435*			-0.263*
Petroleum products tax			1.693*		-0.0268
Admission tax	1.318*				1.511
Transportation tax	1.716*				0.251*
Electricity & gas tax				0.984*	

Note: Elasticities marked by an asterisk(*) are statistically significant at the 5% level.

The forecast results for 1972 and 1973 are presented in Table C. In order to examine the general reliability of the estimating equations, their forecasting performance is reviewed in Table D and in Figure 1 in the Appendix. In general, the forecasting performance of the present model seems to be satisfactory. As plotted in Figure 1, the direction of movement is correctly forecast each year. And Table D shows that the average forecasting error for the year 1971 is within the order of 5 percent. In the cases of the estimating equations for textile products tax and admission tax, however, their forecasting behavior is relatively poor. This may be due to some defects in the formulation chosen for their revenue functions.

As shown in Table C, compared with the 1972 budget estimates, the present models underestimate indirect tax revenues by about 15.8 billion won at current prices. Further, the forecasts show that indirect taxes are projected to grow at an average annual rate of 26 percent in 1972 and 21 percent in 1973, significantly lower than the growth rate attained during the period 1965-1971 (See Table A).

Table C: Annual Projections of Indirect Tax Revenues

(in billions of won)

	1971 actual	1972 budget estimates	1972 projected	1973 projected
Business activity tax	37.9	46.0	51.6	61.5
Commodity tax	34.9	56.3	42.3	50.8
Textile products tax	10.1	16.5	13.0	16.3
Liquor tax	27.7	43.0	33.1	39.5
Petroleum products tax	31.8	40.0	39.4	50.1
Admission tax	4.9	8.7	6.7	7.9
Transportation tax	17.1	13.9	20.6	24.9
Electricity & gas tax	8.2	9.5	11.3	13.4
Total	172.6	233.8	218.0	264.4
Annual % increase	21.1%		26.3%	21.3%

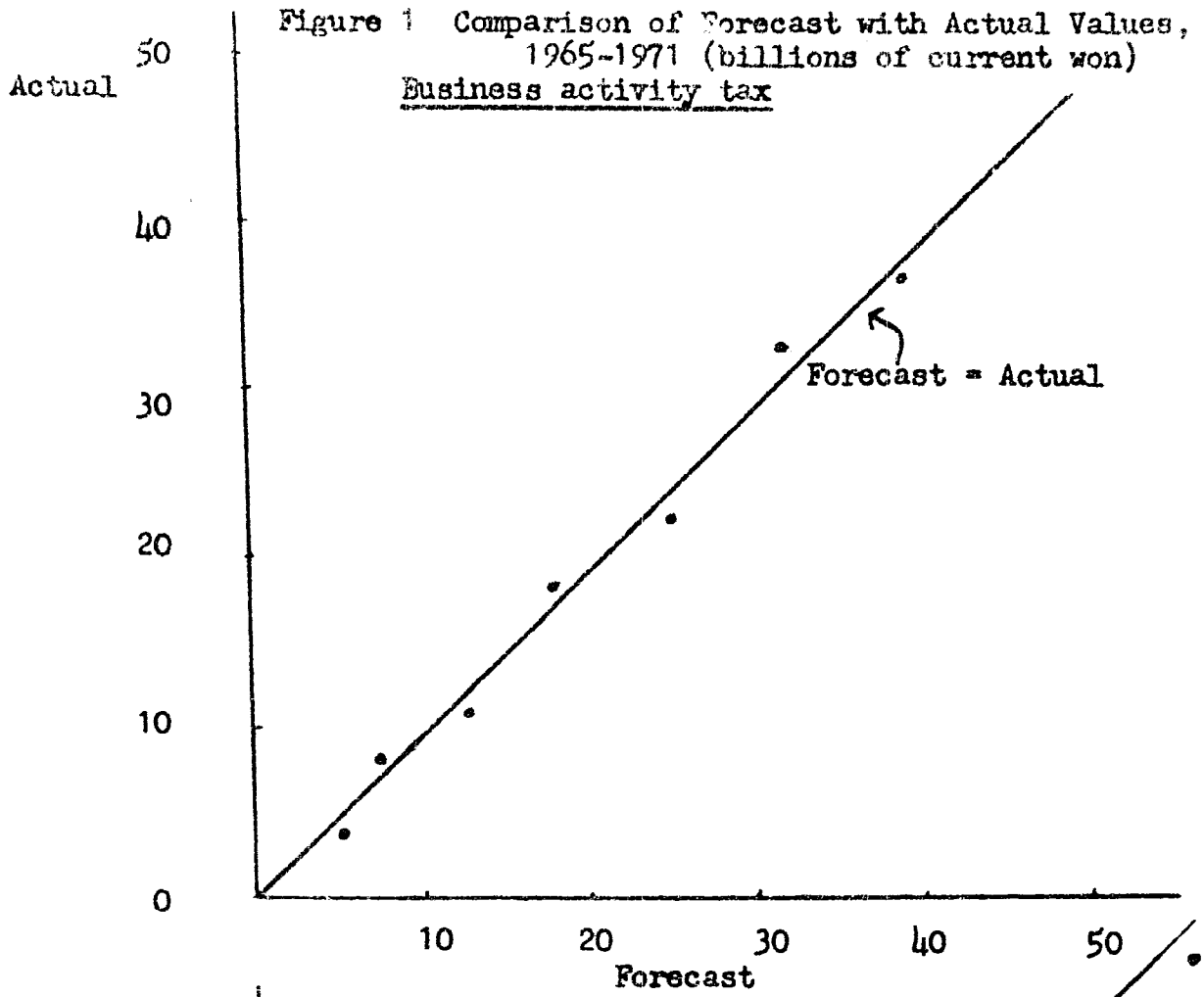
Note: For 1971 actual, "collections in yearly advance" are adjusted.

Table D: Forecasting Performance of the Estimating Equations for the year 1971

(in billions of won)

	Actual Value	Forecast Value	Absolute Error	% Error
Business activity tax	24.2	24.4	+0.2	1.0
Commodity tax	22.8	24.0	+1.2	5.2
Textile products tax	6.7	7.4	+0.7	10.9
Liquor tax	16.0	15.7	-0.3	-1.9
Petroleum products tax	24.0	23.2	-0.8	-3.6
Admission tax	3.1	3.3	+0.2	+7.4
Transportation tax	11.0	10.9	+0.1	+1.2
Electricity & gas tax	5.1	4.9	-0.2	-3.7

Figure 1 Comparison of Forecast with Actual Values, 1965-1971 (billions of current won)



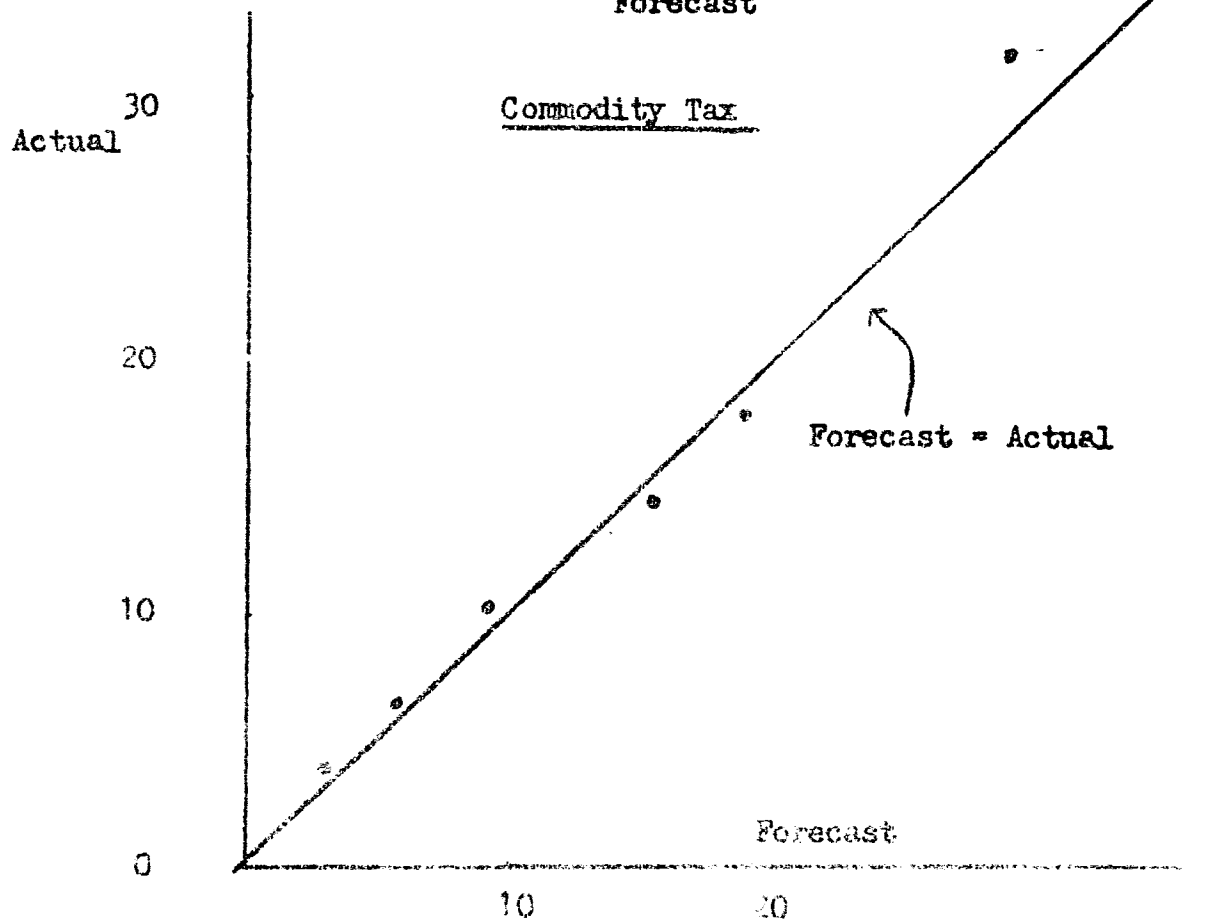
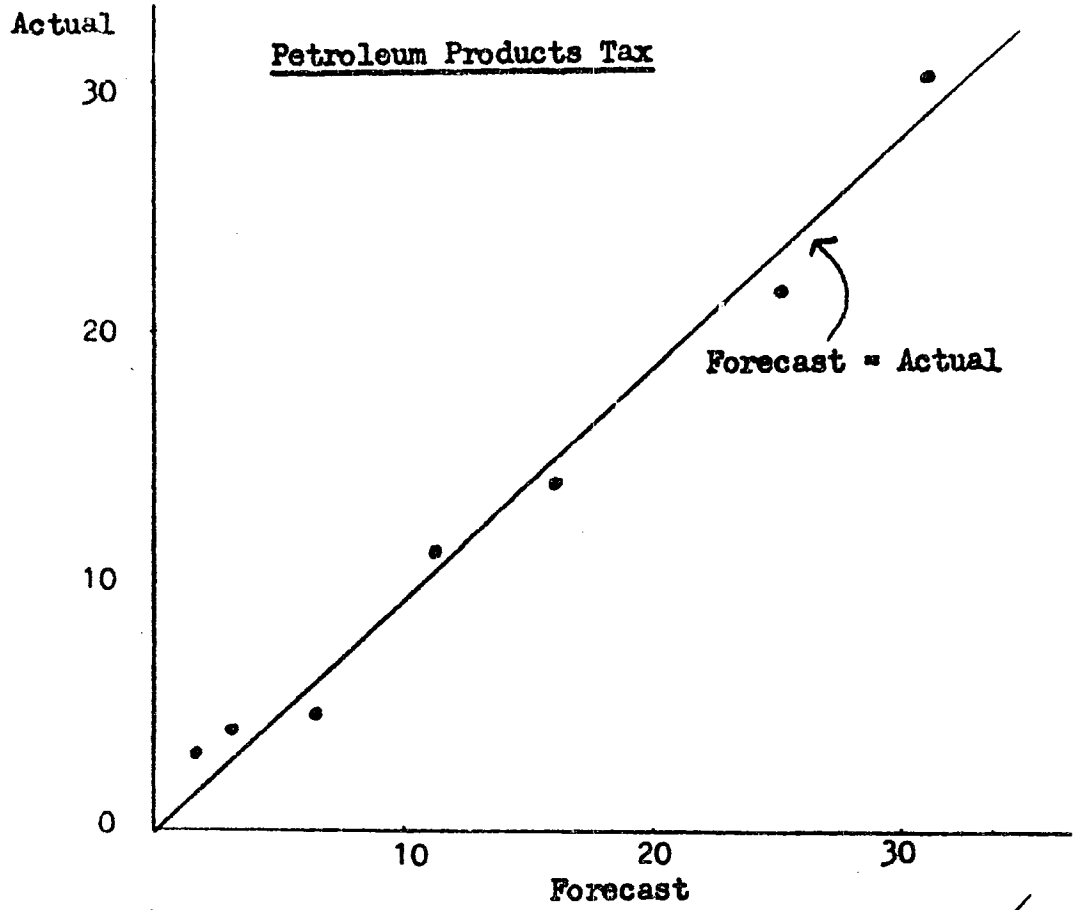
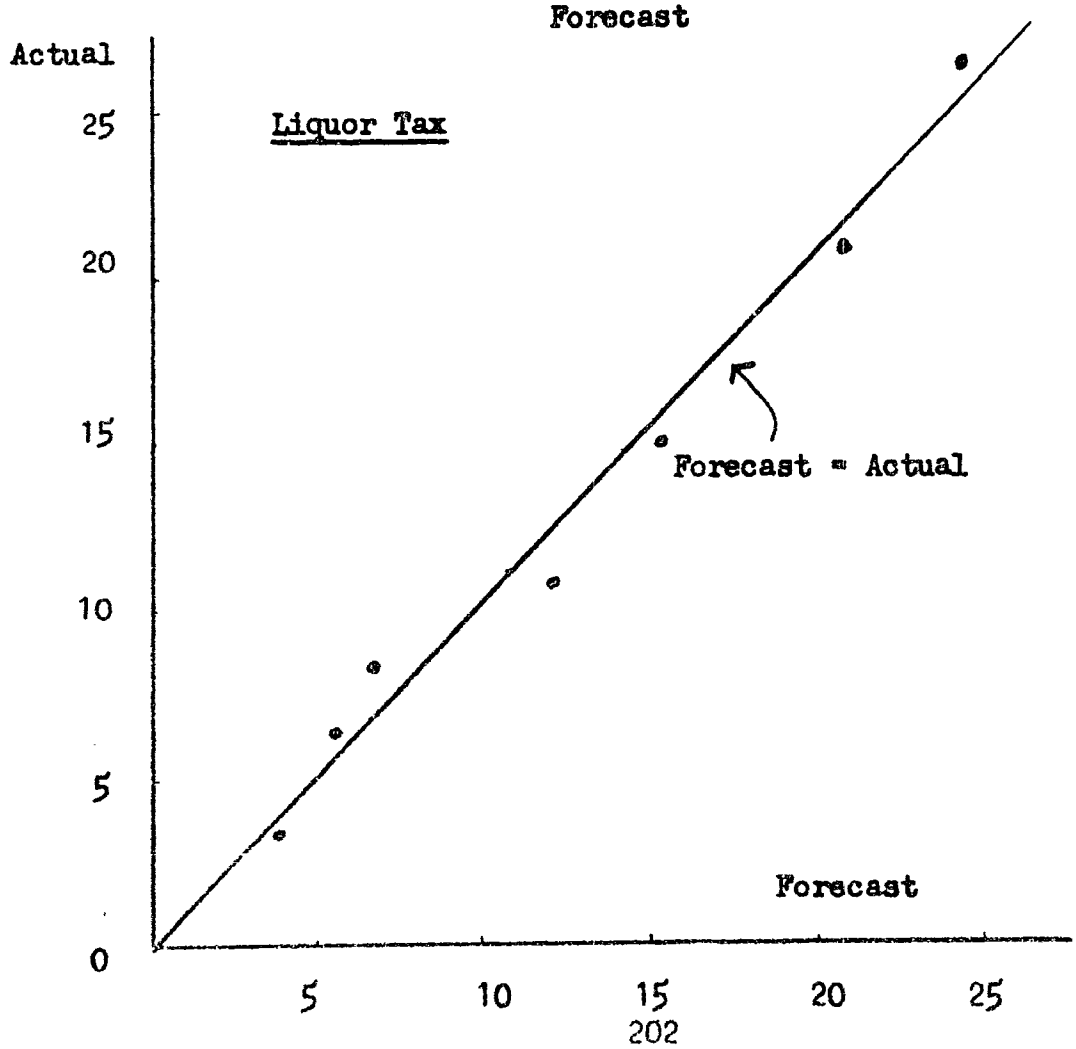


Figure 1 Continued





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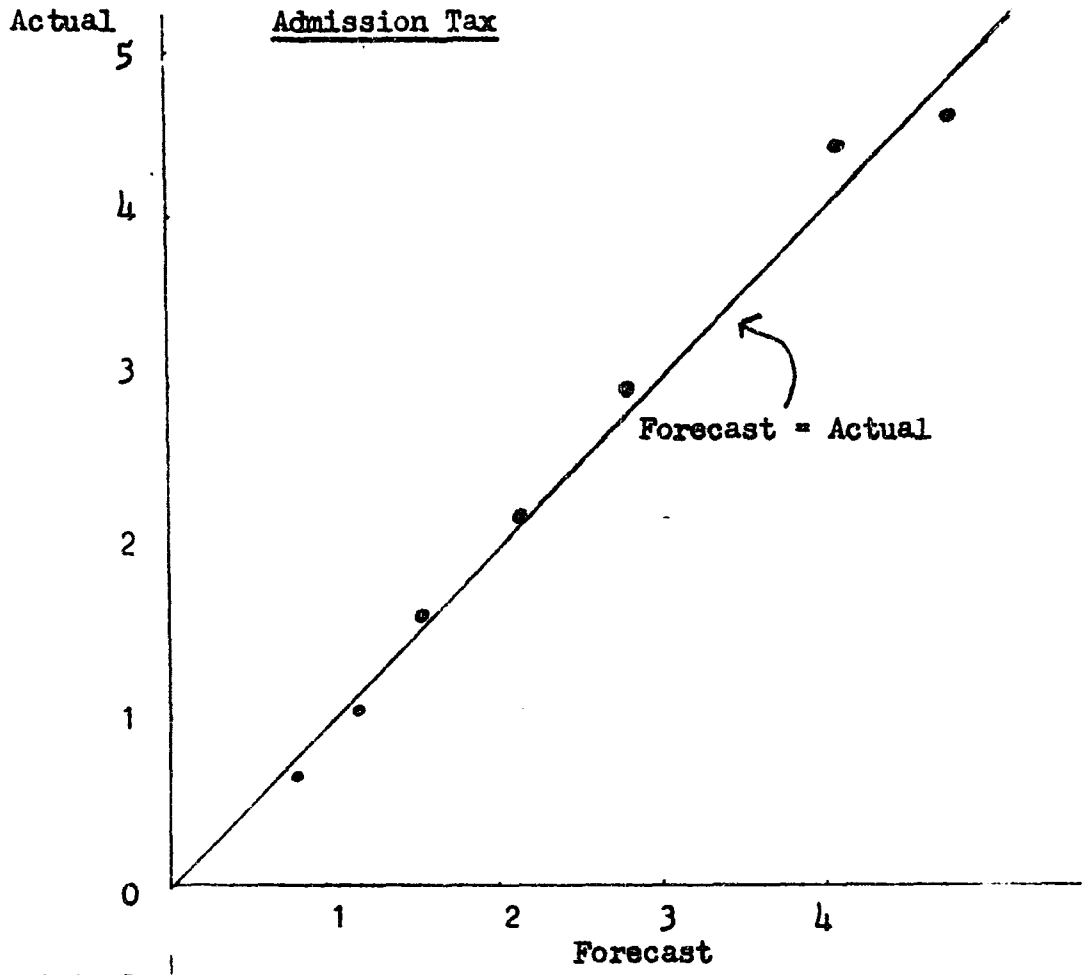

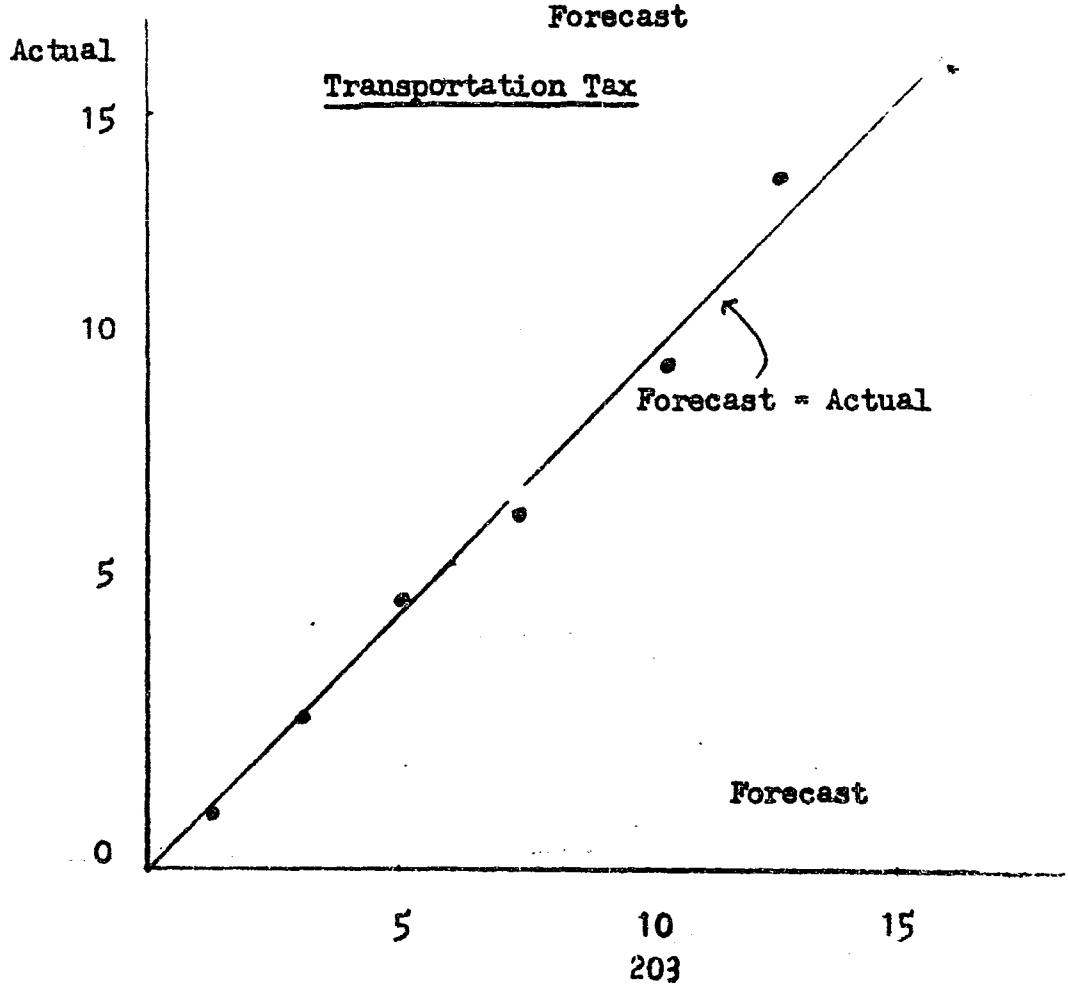

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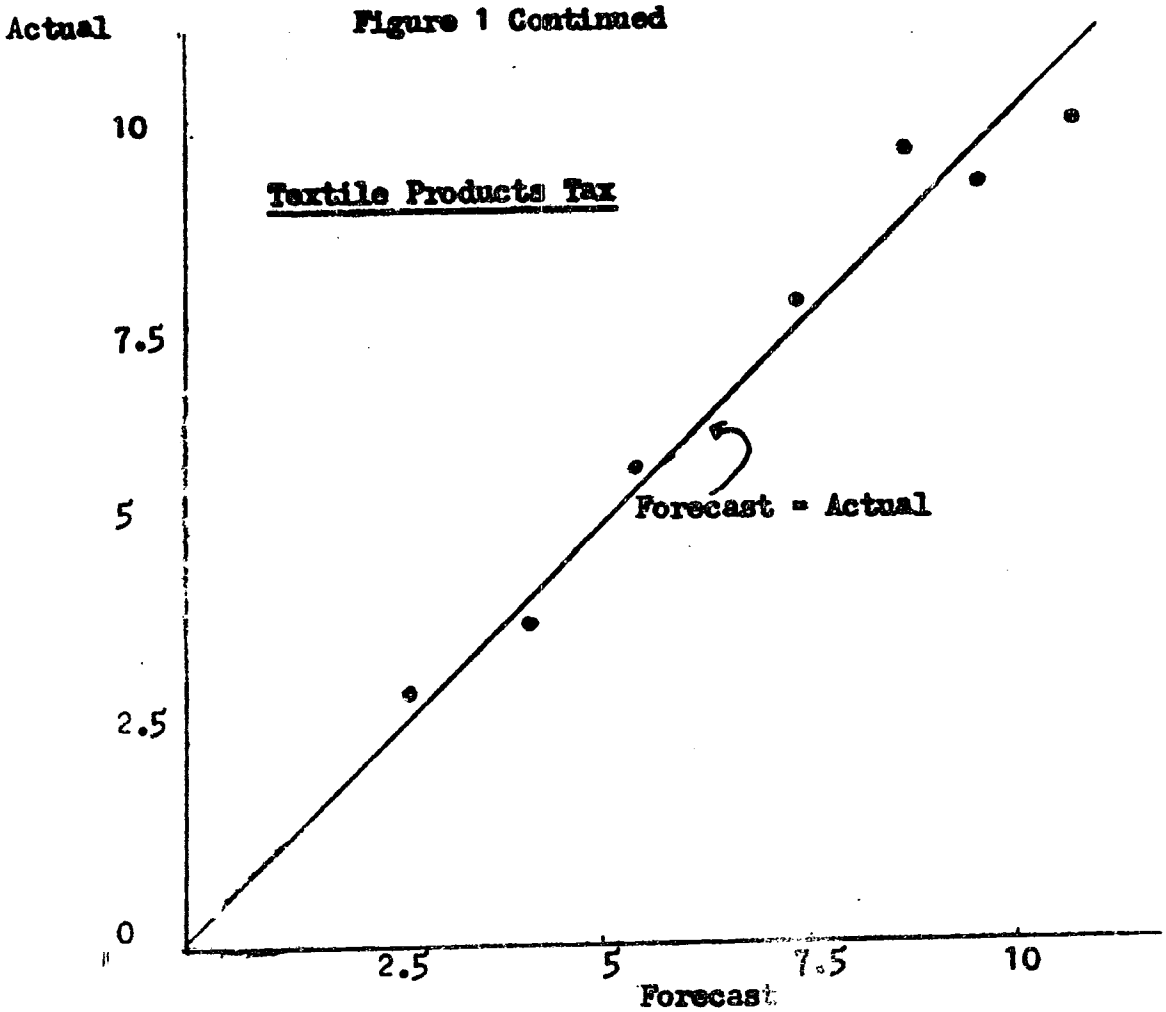

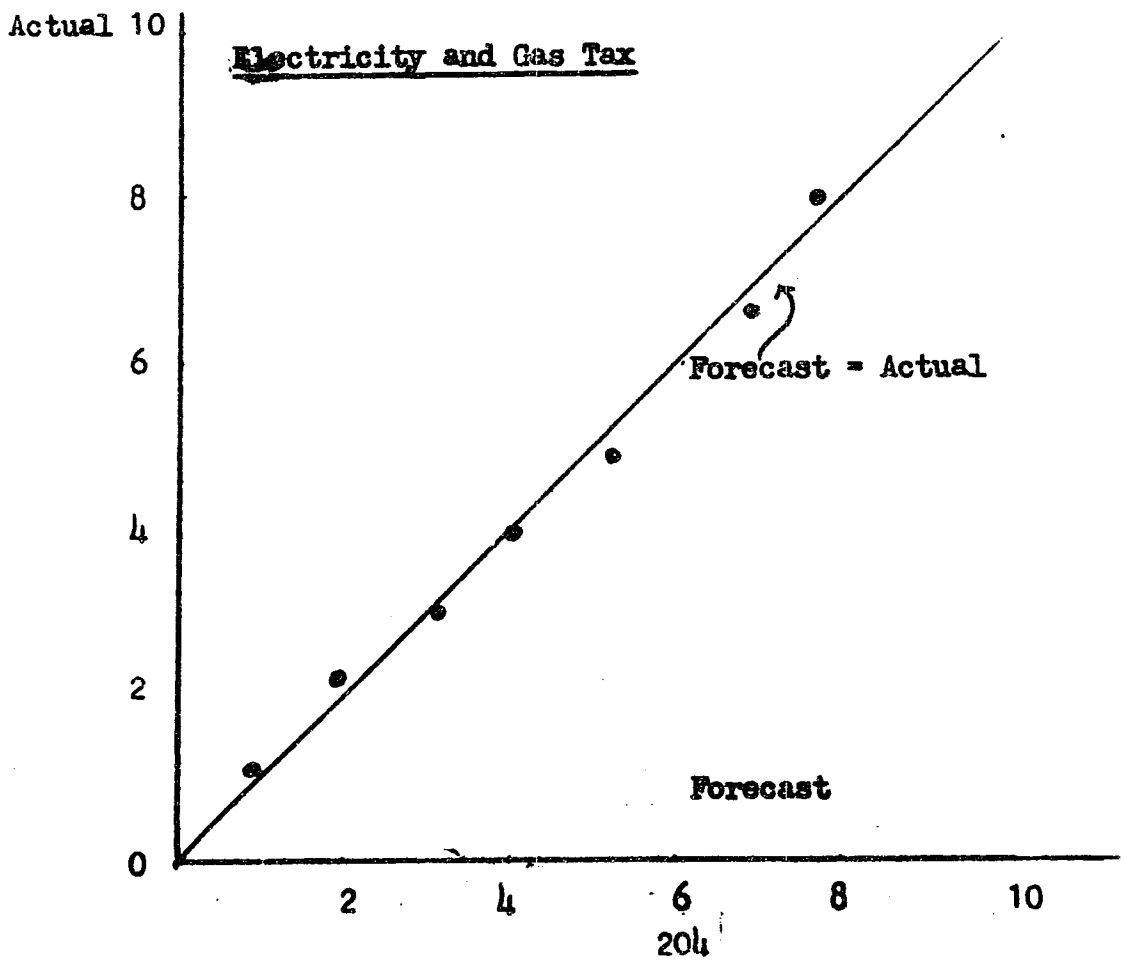

Appendix Table I: Weighted Average Tax Rate (%)

Year \ Items	Business activity tax	Commodity tax	Textile products tax	Liquor tax	Petroleum products tax	Admission tax	Transportation tax	Electricity & gas tax
1965	0.8	20.2	14.0	51.0	66.8	25.5	7.4	15.0
1966	0.8	20.2	14.0	40.3	66.8	25.5	15.3	15.0
1967	0.9	20.2	14.0	76.8	66.8	25.5	15.3	15.0
1968	0.9	23.9	14.3	75.9	126.5	25.5	15.3	15.0
1969	0.9	23.9	14.3	75.8	126.5	25.5	15.3	15.0
1970	0.9	34.0	21.8	75.8	127.0	28.7	15.3	15.0
1971	0.9	34.0	21.8	75.8	127.0	28.7	15.3	15.0
1972	1.3	33.3	21.8	93.9	127.0	33.5	15.7	15.0

Note: the proportions of the 1970 tax yield used as weights, for all the years.

Appendix Table I: Weighted Average Tax Rate (%)

Year	Items	Business activity tax	Commodity tax	Textile products tax	Liquor tax	Petroleum products tax	Admission tax	Transportation tax	Electricity & gas tax
1965		0.8	20.2	14.0	51.0	66.8	25.5	7.4	15.0
1966		0.8	20.2	14.0	40.3	66.8	25.5	15.3	15.0
1967		0.9	20.2	14.0	76.8	66.8	25.5	15.3	15.0
1968		0.9	23.9	14.3	75.9	126.5	25.5	15.3	15.0
1969		0.9	23.9	14.3	75.8	126.5	25.5	15.3	15.0
1970		0.9	34.0	21.8	75.8	127.0	28.7	15.3	15.0
1971		0.9	34.0	21.8	75.8	127.0	28.7	15.3	15.0
1972		1.3	33.3	21.8	93.9	127.0	33.5	15.7	15.0

Note: the proportions of the 1970 tax yield used as weights, for all the years.

Appendix Table I: Weighted Average Tax Rate (%)

Year \ Items	Business activity tax	Commodity tax	Textile products tax	Liquor tax	Petroleum products tax	Admission tax	Transportation tax	Electricity & gas tax
1965	0.8	20.2	14.0	51.0	66.8	25.5	7.4	15.0
1966	0.8	20.2	14.0	40.3	66.8	25.5	15.3	15.0
1967	0.9	20.2	14.0	76.8	66.8	25.5	15.3	15.0
1968	0.9	23.9	14.3	75.9	126.5	25.5	15.3	15.0
1969	0.9	23.9	14.3	75.8	126.5	25.5	15.3	15.0
1970	0.9	34.0	21.8	75.8	127.0	28.7	15.3	15.0
1971	0.9	34.0	21.8	75.8	127.0	28.7	15.3	15.0
1972	1.3	33.3	21.8	93.9	127.0	33.5	15.7	15.0

Note: the proportions of the 1970 tax yield used as weights, for all the years.

Appendix Table II: Adjusted Indirect Tax Yield

(in millions of won)

	Adjusted Tax yield 1969	Collection in advance	Adjusted Tax yield 1970	Collection in advance	Adjusted Tax yield 1971	Collection in advance
Indirect tax	99,316	4,377	137,419	9,374	167,003	14,940
Business activity tax	22,389	642	30,213	1,451	36,496	2,890
Commodity tax	28,956	1,842	31,530	2,004	34,368	2,527
Textile products tax	-		9,664	1,025	10,108	1,009
Liquor tax	15,615	514	20,633	1,622	26,415	2,857
Petroleum products tax	14,342	561	20,152	1,671	30,488	2,940
Admission tax	3,104	87	4,520	187	4,711	396
Transportation tax	9,949	377	13,917	801	16,383	1,566
Electricity & gas tax	4,961	354	6,790	613	8,034	755

Source: Economic Planning Board. For comparison purposes refer to Table A.

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Preliminary and confidential,
Not to be qouted

PRODUCTIVITY ANALYSIS OF KOREAN EXPORT INDUSTRIES

Chuk Kyo Kim

Working Paper 7203

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June 10, 1972

PREFACE

This paper is one in the series of continuing KDI research works which is designed to aid in the formulation of sound public policies and to promote public understanding of issues of the Korean economy.

The interpretations and conclusions in this paper are those of the author and do not represent the views of the Korea Development Institute. Finally, I would like to extend my appreciation to those within and outside of this Institute who have participated in these endeavours.

Mahn Je Kim
President

PRODUCTIVITY ANALYSIS OF KOREAN EXPORT INDUSTRIES

by

Chuk Kyo Kim

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I. INTRODUCTION

One of the most significant features of the economic growth of Korea in the 1960's was an extremely rapid expansion in exports. During the period 1961-70, Korea's exports, as shown in Table I, rose at an average annual rate of 38.5 percent, far exceeding the growth rates of GNP (9.3 percent) and of manufacturing production (18.7 percent). Particularly notable was the sharp increase in merchandise exports which grew at the rate of 65.9 percent per annum during the same period. As exports grew rapidly, the commodity composition of exports has also changed very drastically. The share of manufactured goods, for example, which comprised only 22 percent of total exports in 1961, accounted for 83.6 percent of total exports in 1970.

Numerous factors are responsible for this unusual expansion in exports, although the high growth rate was to some extent attributable to an initially low level of exports in the early sixties. As far as policy measures responsible for this unusual expansion in both output and exports are concerned, one cannot fail to indicate the outward-looking strategies which characterized the basic policy lines of the Korean government during the sixties.[1]

Specifically, the government introduced a series of reforms in the foreign exchange and trade systems. In May 1964 a unitary fluctuating exchange rate system was adopted and at the same time the official exchange rate was devalued from 130 won to 255 won per U.S. dollar. The official exchange rate was, however, reformed in

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[1] Balassa [1], pp. 55ff.

Table I

Growth Rate of GNP, Manufacturing, and Exports [1)]

(in percentage changes)

Year	GNP	Manufacturing	Exports				
			Total	Manufactured goods	Share %	Others	Share %
1961	4.2	4.4	24.5	51.4	22.0	18.6	78.0
1962	3.5	16.8	34.1	64.6	27.0	25.5	73.0
1963	9.1	13.1	58.4	203.2	51.7	4.8	48.3
1964	8.3	6.8	37.2	36.9	51.6	37.5	48.4
1965	7.4	18.1	47.1	77.6	62.3	14.6	37.7
1966	13.4	24.4	43.0	43.2	62.4	42.6	37.6
1967	8.9	30.1	27.9	43.7	70.1	1.7	29.9
1968	13.3	34.7	42.2	56.8	77.3	8.0	22.7
1969	15.9	21.8	36.7	39.7	79.0	26.5	21.0
1970	8.9	16.6	34.2	42.0	83.6	4.8	16.4
1961-70	9.3	18.7	38.5	65.9	58.7	18.5	41.3
1965-70	11.3	24.3	38.5	50.5	72.5	16.4	27.5

1) All in constant prices except exports

Sources: Economic Statistics Yearbook, Bank of Korea 1971

December 1965 by fixing it again at 270 won to 1 U.S. dollar. While import policy has been liberalized considerably since then, a comprehensive scheme for export promotion has also been put into effect and extended in the subsequent years.

In view of the urgent need to improve the continuing balance of payments deficits and to meet increasing foreign exchange requirements, the government set annual export targets and took whatever measures necessary to attain them. To support this, a variety of indirect export promotion measures were adopted: income tax reduction, exemption from business activities and commodity taxes, preferential export credits and loans, high wastage allowance on imported raw materials for exports, etc.

Although export promotion measures have much contributed to rapid export growth since 1965, such an export drive policy has posed a number of problems, particularly with regard to the efficiency of resources allocation, for export growth has not been guided by the principle of comparative advantage but has been, to a large extent, dictated by non-economic considerations which may have led to a considerable amount of resources waste.

The major purposes of the present paper are (1) to examine the relationship between exports and productivity growth of the Korean manufacturing industries between 1966 and 1970, and (2) to make productivity comparisons among export, import-substitution, and domestic sectors in order to assess critically Korea's export performance during this period. It is emphasized that exports are determined not only by productivity changes but by a variety of factors

such as demand conditions in the world market, relative prices, and exchange rate policy. However, the impact of factors other than productivity changes on the export growth is not analyzed in the present paper. Neither is it attempted in the present paper to make an international comparison of the competitiveness of the Korean export industries.

The scope of the study and the method of productivity measurement are outlined in Section II; the statistical findings on total factor productivities of export industries are given in Section III and productivity trends are examined in connection with the export performance of individual industries. Section IV deals with the relationship between factor prices, factor intensity, and productivity growth. Productivity comparisons among export, import-substitution, and domestic sectors are made in the next section. Finally, Section VI tries to draw some policy implications for future export promotion.

II. SCOPE AND METHOD OF PRODUCTIVITY MEASUREMENT

1). Scope of the Study

Using the Korean Standard Industrial Classification (KSIC), we have classified whole manufacturing industries at the 4-digit level into three categories; export, import substitution, and domestic industries. Export industries are defined as those manufacturing industries whose average export ratio exceeds 10 percent between

1966 and 1970,[2] while import substitution industries defined as those industries showing an average import ratio higher than 30 percent.[3] The rest of the manufacturing industries are classified as domestic industries. We confine our study only to the period 1966-70 because of data availabilities.

Since we are mainly concerned with the productivity analysis of export industries, their measurements will be made both at disaggregate (4 and 2-digit level) and aggregate levels, while those of non-export industries are made at 2-digit and aggregate levels. In addition to the productivity analysis, an attempt will be made to measure factor shares of income in three different industries during the period 1966-70; also, trends of factor shares are examined in connection with factor prices and factor intensity in the export industries.

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[2]The exports of industries so classified comprised, on average, about 90 percent of total exports of manufactured goods between 1966 and 1970.

[3]We apply an import ratio which is higher than the export ratio because in Korea most industries were initially import substitution industries which were transformed into either export or domestic industries. Therefore, the application of an import ratio as low as the export ratio might lead to an exaggeration of import substitution industries.

2). Method of Productivity Measurement

Total factor productivity is measured along the lines suggested by John W. Kendrick[4] which can be expressed as

$$T_{t/0ij} = \frac{V_{ij,t} \quad / \quad V_{ij,0}}{\alpha_{ij,0}\frac{L_{ij,t}}{L_{ij,0}} + (1-\alpha)_{ij,0}\frac{K_{ij,t}}{K_{ij,0}}} \qquad (1)$$

where $T_{t/0ij}$ is the total productivity index for the jth 4-digit industry in the ith 2-digit industry. V is value added in constant prices, L is the number of employees, K is the real capital stock, and α is the labor share at net factor cost in the base year.

Since all inputs are weighted by their base year prices, the total factor productivity index measures the change in output per combined factor input changes between two periods, had the prices of factors of production in the base year prevailed. In other words, it measures efficiency change in the use of resources, reflecting the "Residual".[5]

---

[4] Kendrick [4]

[5] The numerical result of "Residual" measured by the total factor productivity index does not differ much from the one measured by a Cobb-Douglas production function. It differs only in that the former combines changes in output, labor, and capital multiplicatively, whereas the latter uses the additive combination of three factors, namely, $R = \mathring{V}/V - \alpha\mathring{L}/L - (1-\alpha)\mathring{K}/K$, where R is the residual. Because of this difference, the total factor productivity index tends to underestimate the Residual as compared with the Cobb-Douglas production function. The difference is, however, negligible for the short period. See, Riese [7, p. 301], Brown [2, pp. 98f], Domar [3, p. 641].

All inputs are supposed to represent services of individual factors with which are directly utilized in production. Labor input should be measured in terms of man-hours and capital input in terms of capital services which take into account the degree of capacity utilization. Unfortunately, no data is available for man-hours and capacity utilization in the Report of Manufacturing Census. Hence, we have simply used an average number of employees and real capital stock as factor inputs. On the other hand, we have used electricity consumption in kilowatts as a proxy variable for capital input.

Equation (1) is in principle appropriate to measure the total factor productivity of an individual, homogeneous industry. For the economy as a whole or an industry at an aggregate level, labor and capital in different industries should be weighted by their respective prices, because the productivities of labor and capital are different in different industries. The weighted total productivity index for the ith 2-digit level industry can be expressed as

$$T^{*}_{t/0i} = \frac{\dfrac{\sum V_{ij,t}}{\sum V_{ij,0}}}{\alpha_{i,0}\dfrac{\sum m_{ij,0}\, L_{ij,t}}{\sum m_{ij,0}\, L_{ij,0}} + (1-\alpha)_{i,0}\dfrac{\sum n_{ij,0}\, K_{ij,t}}{\sum n_{ij,0}\, K_{ij,0}}} \qquad (2)$$

where $m_{ij,0}$ is the real wage rate in the jth 4-digit industry in the ith 2-digit industry in the base year and $n_{ij,0}$ is the base year rate of return on capital[6] in the jth 4-digit industry in the ith 2-digit

---

Rate of return on capital is defined as V-W/K where V, W, and K denote value added in constant prices, real labor compensation and real capital stock respectively.

industry. Since labor and capital in different industries are weighted by their prices in the base year, the weighted productivity index measures efficiency change in production within the individual industries. In other words, productivity increases due to the shift of resources from less productive to more productive industries are eliminated in the weighted total productivity index.

3 Statistical Data

The data used in the present study are all taken from the Report on Mining and Manufacturing Census and Surveys from 1966 through 1970. Before 1966, no annual Report was available except for 1960 and 1963. Therefore, we confine our analysis to the period 1966-70.

The basic data we need, such as output, value-added, tangible fixed assets, number of employees, employees' remuneration, etc., are all given in the Report, and are classified by KSIC 2-digit and 4-digit levels. As far as tangible fixed assets are concerned, the data are available only for 1966 and 1968. The capital stock figures for the remaining years are estimated by means of the bench-mark year method as follows:

$$K_{t+1} = K_t + I_{t+1} - D_{t+1} ,$$

where

K_t = Fixed tangible assets excluding land in year t

I_{t+1} = Investment in tangible fixed assets excluding land in year t+1

D_{t+1} = Disposal of tangible fixed assets excluding land in year t+1

The estimated capital stocks based on the 1966 benchmark year do not, however, coincide with the one based on the 1968 benchmark year. In general the former rises faster than the latter. In view of the relatively small yearly fluctuations at the industrial level, the capital stock series based on the 1968 benchmark year seem much more preferable for productivity analysis. For the sake of comparison, however, both series are used in the measurement of capital and total factor productivity. Since information on depreciation is available only for one year (1968), no attempt is made to measure net capital stock. Hence, capital stocks are on gross terms. Capital stocks at current prices are deflated by using a GNP deflator for fixed capital formation. We have constructed a price index for each industry at the 4-digit level, and this is used to deflate value added in individual industries.

III. EXPORT AND PRODUCTIVITY GROWTH

1. Export and Total Productivity Growth

Table II shows output (value added), exports, and total factor productivity growth of export industries during the period 1966-70. For the convenience of the discussion, figures are given only at 2-digit industrial level. We have shown two different total factor productivities, one based on the 1966 capital stock series, the other on the 1968 capital stock series.

In Table II, we first note that exports grew much faster than value added in the export industries, implying that an increasing

portion of output has been exported between 1966 and 1970. Exports grew at an average annual rate of 36.7 percent as against the 22.4 percent growth rate of value added.[7]

In spite of this rapid expansion of both output and exports, the productivity growth of the export industries as a whole was relatively low. The total factor productivity based on the 1968 capital stock series showed an average annual growth rate of 8.9 percent between 1966 and 1970. Productivity growth was slightly lower (7.4 percent) when the 1966 capital stock series are used as capital input. This is simply due to the fact that the 1966 capital stock series rose much faster than the 1968 capital stock series. Generally, we can say that the productivity contribution to export growth during the period 1966-70 was very low; productivity growth accounted for about 20 percent of export growth, with the rest being explained by factors other than productivity improvements.

The weighted total factor productivity growth was, as expected, much lower than the unweighted. The weighted productivity growth based on the 1966 capital stock series indicates only 2.3 percent growth while the one using the 1968 capital stock series gives a 5.4 percent growth rate. Since the weighted total productivity excludes the increase in productivity due to the shift of resources from lower to higher productivity industries, the extremely low growth rate of productivity implies only a little efficiency improvement in export industries between 1966 and 1970, and the major portion of the productivity gain is attributable to the structural changes within the export sector.

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[7] Even if we take production value instead of value added, the difference between the growth rate of exports and that of output is almost the same because the income ratio (ratio of value added to production) remained stable between 1966 and 1970.

Table II

Growth Rate of Output, Exports, and Total Factor Productivity, 1966-70

Industrial group	Number of 4-digit industries	Value Added	Exports	Total Factor Productivity[1] unweighted	Total Factor Productivity[1] weighted	Total Factor Productivity[2] unweighted	Total Factor Productivity[2] weighted
Food manufacturing	3	18.3	12.8	11.8	12.9	10.7	12.0
Textiles	12	30.0	35.7	10.3	4.4	12.1	9.9
Footwear, wearing apparel & made-up textile goods	9	17.9	49.3	3.4	0.3	6.0	6.2
Wood products	2	39.5	31.3	9.0	2.5	-6.1	-8.7
Leather products	1	40.7	68.5	28.6	28.6	30.5	30.5
Rubber products	2	29.0	37.4	14.9	14.2	10.3	10.3
Clay, glass & stone products	2	24.1	225.4	3.2	-5.0	2.3	0.0
Basic metal industries	1	31.1	72.4	18.0	18.0	7.1	7.1
Metal products	2	9.7	26.9	6.1	5.9	5.6	4.7
Machinery	2	-6.4	69.4	-7.5	-1.1	-11.5	-11.6
Electrical machinery, apparatus & appliances	2	40.8	20.4	10.1	7.5	31.6	30.3
Other manufacturing industries	4	64.4	58.5	12.2	9.3	14.2	9.5
Total exports industries	42	22.4	36.7	7.4	2.3	8.9	5.4

1) Based on the 1966 capital stock series.
2) Based on the 1968 capital stock series.

2. Exports and Total Productivity Growth of Individual Industries

Although the exports of manufacturing industries as a whole grew rapidly between 1966 and 1970, there were substantial inter-industrial growth differentials. The export of clay and stone products such as ceramic setts, flags and tiles rose at an annual rate of 225.4 percent, the highest growth among the export industries. The export of basic metal industries, machinery, and leather products also grew very rapidly, the average annual growth rate being 72.4, 69.4, and 68.5 percent, respectively. The exports of textiles, made-up textile goods including footwear, and wood products, which constitute the major export industries of Korea, also indicate relatively high growth rates of 35.7, 49.3, 31.3 percent, respectively. Industries showing relatively modest export growth were food manufacturing, metal products and electrical machinery and apparatus.

Similarly, the growth of total factor productivity varied a great deal among industries. On the basis of the 1968 capital stock series, the highest productivity growth was gained in electrical machinery and apparatus where total factor productivity rose at an average annual rate of 31.6 percent between 1966 and 1970. Leather products showed the second highest productivity growth of 30.5 percent per annum. The industries indicating productivity growth of more than 10 percent are food manufacturing (10.7%), rubber products (10.3%), textiles (12.1%), and other manufacturing industries such as toys, wigs and optical instruments (14.2%).

It is surprising to observe that industries with a rapid expansion in exports demonstrate in most cases either a low or even

a negative productivity growth. A very low productivity growth is observed in such industries as clay and stone products, made-up textile goods, metal products and basic metal industries. Machinery and wood products indicate a negative productivity growth, which may imply that these industries are operating at a loss.[8] If we look at weighted total productivity, productivity growth of individual industries has been in general much lower than the unweighted productivity growth. As already indicated, the export sector as a whole shows a growth rate of only 5.4 percent in productivity improvements.

Productivity gains are even less, when the 1966 capital stock series are used. As Table II indicates, besides wood products and machinery, clay and stone products show a negative productivity growth; insignificant productivity gains (0.3%) are registered in footwear and made-up textile goods, while a modest productivity growth (4.4%) is found in textiles, the major export industry in Korea. Thus, total productivity in the export sector as a whole indicates a low growth rate of 2.3 percent, compared with the 36.7 percent growth rate of total exports. In conclusion, it seems safe to say that productivity growth in terms of increase in efficiency has made virtually no contributions to the export performance of the Korean manufacturing industries during the period 1966-70. There is further

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[8] Remember that our total productivity is measured at domestic prices which are likely to be higher than export prices. This implies that if output is measured at export prices, total factor productivity growth would be much lower than otherwise, with the result that a number of other industries, particularly those with a low productivity growth would also show a negative productivity growth. In fact, many Korean exporters have been making negative profits. The losses have been offset by subsidies and high profits from domestic sales.

empirical evidence to substantiate these observations; our simple correlation analysis confirms a weak association between export performance and productivity growth.

As Table III demonstrates, food manufacturing, textiles, rubber products, and electrical machinery and apparatus indicate high correlation coefficients between their exports and total factor productivity growth. The correlation coefficients for other industries are either low or negative. The correlation coefficient between exports and labor productivity growth is also generally low for export industries, except textiles, rubber products, and electrical machinery and apparatus. In contrast to their low correlation with productivity growth, exports are relatively highly correlated with output growth (see Table III). The correlation coefficients between exports and value added are high except for leather products, clay and stone products, basic metal industries, and machinery. These statistical results reflect fairly well a situation in which exports are made regardless of costs and competitiveness of products, so that supply becomes a main constraint of export promotion. Indeed, this was what happened in many export industries between 1966 and 1970.

IV. FACTOR PRICES, FACTOR INTENSITY, AND PRODUCTIVITY GROWTH

1. Relative Factor Prices and Capital Intensity

In this Section, we shall attempt to investigate the impact of factor price changes on factor intensity and productivity growth, and how productivity gains are distributed among factors of production.

Table III

Coefficient of Correlation of Exports with respect to and Output and Productivity Growth

Industrial Group	Value Added	Total Factor Productivity[1] unweighted	Labor Productivity
Food manufacturing	0.89	0.93	0.59
Textiles	0.97	0.95	0.94
Footwear, wearing apparel & made-up textile goods	0.91	0.64	0.70
Wood products	0.98	-0.21	0.71
Leather products	0.07	-0.09	-0.28
Rubber products	0.94	0.92	0.91
Clay, glass & stone products	-0.11	-0.43	-0.16
Basic metal industries	-0.38	-0.60	0.12
Metal products	0.58	0.48	0.74
Machinery	-0.22	-0.52	0.67
Electrical machinery, apparatus & appliances	0.80	0.80	0.88
Other manufacturing industries	0.95	0.70	0.56

1) Based on the 1968 capital stock series.

Table IV shows changes in factor prices and capital intensity of export industries during the period 1966-70. Factor prices are defined as the ratio of current-price factor compensation to real factor input, as suggested by J.W. Kendrick. In the following, we use only the capital stock series based on the 1968 benchmark year method.

The price of labor more than doubled between 1966 and 1970, while the price of capital increased by only 64.2 percent during the same period. Since the price of labor rose faster than that of capital, there should have been factor substitution in favor of capital.[9] This is confirmed by our empirical findings on the change in capital intensity. As shown in Table IV, the capital-labor ratio of the export sector as a whole rose by 32.1 percent between 1966 and 1970. A relatively rapid increase in the price of labor in relation to the price of capital and a resultant increase in capital intensity are found in all export industries. The exceptions are found in electrical machinery and apparatus in which a declind in capital intensity is

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[9] In view of the situation in Korea where labor is relatively redundant in relation to capital, one may wonder why the price of labor rose much faster than that of capital. The rapid increase in the price of labor relative to the price of capital seems partly a reflection of an imperfect labor market in which the market wage rate is not only higher than the shadow price of labor, but also is determined by factors other than demand and supply conditions. The increasing demand for skilled and semi-skilled labor concomitant with a rapid growth might also have contributed to the relatively rapid rise in labor price. The other reason seems to be easy access to relatively cheap foreign capital which have been the major sources of financing during this period. In this connection, one should not forget that imported technology is more capital intensive than the existing technology. In conclusion we can say that the increased capital intensity during the period 1966-70 is partly attributable to the relative factor price changes and partly to imported technology.

observed (see Table V).[10]

2. Export Ratio, Capital Intensity, and Productivity Growth

We have explained the increase in capital intensity in terms of changes in relative factor prices. We shall now investigate the relationship between factor intensity and productivity growth.

As Table V exhibits, the capital intensity of the export sectors rose at an average annual rate of 7.5 percent during the period 1966-70, accompanied by 13.8 percent growth of labor productivity.[11] This is due to the positive growth of total factor productivity which shows an average annual growth rate of 8.9[12] percent between 1966 and 1970. Since total productivity rose faster than the rate of factor substitution, capital-output ratio[13] is supposed to fall. This is confirmed by the increase in capital productivity, the annual average growth rate of which is 6.4 percent.

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[10] Footwear, wearing apparel and made-up textile goods indicate also a decline in capital intensity. But this seems due to an overestimate of capital stock in the initial year. The capital stock in 1966 is larger than that in 1970, which seems rather unreasonable. When we consider only the period 1967-70, we find 7.2 percent of average annual increase in capital intensity.

[11] The labor productivity and capital intensity of individual industries are shown in Table II and Table III in the appendix.

[12] Our estimate of the "Residual" with a Cobb-Douglas production function gives 9.3 percent during the same period. Although this numerical difference is, as already indicated, due to the difference in the mathematical nature of the two approaches, total factor productivity of the Kendrick type seems in general preferable to a Cobb-Douglas function, since the former does not necessarily assume an elasticity of substitution of one and constant returns to scale as the latter does. As will be shown later, the elasticity of substitution is less than one in export industries between 1966 and 1970.

[13] See Table II in the appendix.

Table IV

Changes in Factor Prices and Factor Intensity in Export Sector

Year	Price of Labor 1)	Price of Capital 2)	Capital Intensity
1966	100.0	100.0	100.0
1967	124.7	99.3	100.4
1968	149.9	140.0	102.8
1969	210.5	151.5	111.3
1970	235.8	164.2	132.1
Average Rate of changes, 1966-70	24.3	14.2	7.5

1) Current-price labor compensation divided by average number of employees.

2) Current-price capital compensation divided by real capital stock (1968 capital stock series). Current-price capital compensation is abtained when we subtract current-price labor compensation from gross value added at current price.

Looking at the industrial level, we find considerable variation in the changes in capital intensity among different industries. Heavy industries such as basic metal industries, machinery, and wood products show a sharp increase in capital intensity, whereas such light consumer goods industries as food manufacturing, textiles, and leather products indicate a small increase in the capital-labor ratio. Industries showing a negative growth of capital-labor ratio are electrical machinery and apparatus, and footwear and made-up textile goods.

In this connection, it is interesting to observe that industries with a relatively low increase in capital intensity tend to be associated with a relatively high total productivity growth. This seems partly due to the fact that because of a relatively high share of capital income, as will be shown later, the relatively rapid increase in capital input in relation to labor input led to a much greater increase in the total factor inputs than otherwise. This resulted in the relative downward trend in total productivity growth. In other words, total productivity growth is strongly affected by the movements of capital input rather than that of labor input because of the relatively high weight of capital input. On the other hand, it seems that the productivities of capital intensive industries are relatively low largely because of lack of economies of scale due to a small size of plant. The low capacity utilization and inefficient management might also have contributed to the low productivity growth in industries.[14] In contrast to capital

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[14] The capacity utilization ratio was in general very low in machinery and basic metal industries between 1967 and 1970. See, Korea Industrial Development Institute [6, pp. 146 ff.].

intensity, there is no definite relationship between export ratio and productivity growth (see Table V).

3. Factor Shares of Income

We have already indicated that the price of labor has increased much faster than that of capital between 1966 and 1970. Although capital intensity has also increased, the rate of increase is lower than the difference between the rate of increase in labor and capital price. In other words, labor's share of income must have increased between 1966 and 1970, for the relative increase of the price of labor in relation to the price of capital is higher than the increase in capital labor ratio.

According to Table VI[15], the labor share of income in the export sector as a whole shows a slightly upward trend between 1966 and 1970: it rose from 37.9 in 1966 to 39.8 in 1970. No information on indirect taxes is available for 1969 and 1970. Therefore, the labor share for these two years is somewhat underestimated. The rising trend in the labor share is observed for most of the export industries.

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[15] The labor share of income is estimated in the following way: The labor compensation for employees is given in the Manufacturing Census. The labor compensation for an unpaid family worker or a proprietor is imputed on the assumption that these people are paid the average compensation per employee. This may not be very realistic. But in view of the fact that the productivity of an unpaid family worker is likely to be lower while that of a proprietor higher than the average productivity of employee, our estimate seems to provide a good approximation. The sum of employee compensation and the imputed compensation for unpaid family workers and proprietors gives total labor compensation. The ratio of total labor compensation to value added, net of depreciation and indirect taxes, gives the labor share of income. As indicated already, figures on depreciation are available only for 1968. We have calculated the depreciation ratio (ratio of depreciation to gross value added) for 1968, and this ratio is applied to the remaining years.

Table V. Export Ratio, Factor Intensity, and Productivity Growth, 1966-70[1)]
(in percentage changes)

Industrial Group	Export Ratio	Capital-labor Ratio	Total Factor Productivity (Unweighted)	Labor Productivity	Capital Productivity
Food manufacturing	93.5	7.0	10.7	13.4	10.4
Textiles	28.6	5.9	12.1	15.9	10.1
Footwear, wearing apparel & made-up textile goods	69.8	-2.0	6.0	3.0	8.7
Wood products	65.7	41.7	-6.1	10.1	-11.2
Leather products	71.1	6.5	30.5	7.3	44.6
Rubber products	16.3	24.0	10.3	25.1	2.8
Clay, glass, & stone products	25.3	17.8	2.3	3.1	6.7
Basic metal industries	42.5	84.8	7.1	18.9	8.8
Metal products	63.8	8.3	5.6	9.0	4.5
Machinery	29.3	30.1	-11.5	6.6	-19.7
Electrical machinery, apparatus & appliances	15.2	-1.5	31.6	31.0	33.9
Other manufacturing industries	130.9	17.4	14.2	12.6	24.1
Total exports industries	44.7	7.5	8.9	13.8	6.4

1) Capital data are all based on the 1968 capital stock series.

Table VI

Labor Share of Income in Export Industries

Industrial Group	1966	1967	1968	1969	1970
Food manufacturing	32.5	40.5	35.2	34.7	35.4
Textiles	40.9	38.6	40.0	40.5	40.7
Footwear, wearing apparel & made-up textile goods	35.2	36.2	38.3	45.2	43.1
Wood products	35.8	40.9	30.1	48.3	38.5
Leather products	25.9	39.4	28.5	44.7	46.4
Rubber products	49.9	44.8	41.6	41.6	41.4
Clay, glass,&stone products	17.7	36.0	45.9	45.2	44.9
Basic metal industries	19.8	53.4	51.9	28.9	32.0
Metal products	34.5	49.9	39.5	46.4	52.3
Machinery	30.3	42.3	50.7	37.0	43.9
Electrical machinery, apparatus & appliances	33.8	64.3	44.0	31.8	30.5
Other manufacturing Industries	29.3	54.2	36.8	41.9	40.1
Total exports industries	37.9	40.1	38.9	41.2	39.8

Rubber products and electrical machinery and apparatus are the only exceptions in which labor shares show a declining trend. The labor share is very stable in food manufacturing and textiles, while an apparently rising trend is found in all other industries. It is remarkable that the labor share of income is less than fifty percent for all export industries.

The rising trend in labor share implies, on the other hand, that the elasticity of substitution between capital and labor is not unity. In other words, the Cobb-Douglas type of production function is not applicable to Korean export industries during the period 1966-70. In order to test this, we have calculated the elasticity of substitution using the following formula:[16]

$$\sigma = \frac{G_K - G_L}{G_W - G_K} ,$$

Where σ is elasticity of substitution, G_K is the growth rate of real capital stock, G_L is the growth rate of employee, and G_W and G_K are the growth rates of real prices of labor and capital respectively. Between 1966 and 1970 we obtain the following results:

$$\sigma = \frac{0.221 - 0.139}{0.173 - 0.082} = 0.892$$

The elasticity of substitution of 0.892 suggests that some other type of production function is more appropriate than that of the Cobb-Douglas type for export industries. As will be shown below,

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[16]See, Kendrick and Sato [4, p. 989].

this seems true not only of export industries, but also of total manufacturing industries as a whole.

We have further estimated the labor share of income for import substitution, domestic, and total manufacturing industries (see Table VII). The import substitution industries indicate a more or less constant labor share of income while an apparently declining trend is found in both domestic and total manufacturing industries between 1966 and 1970. The labor share in import substitution industries has remai mained almost constant at 29.5 percent from 1966 through 1970, although there are small yearly fluctuations during the period. In contrast to import substitution industries, the labor share in domestic industries shows a relatively rapid decline during the period 1966-70. It fell from 28.5 to 24.0 percent, leading to the downward trend in labor share in total manufacturing industries, for the domestic sector assumes a dominant position in total manufacturing industries.[17]

The rise in labor share of income between 1966 and 1970 in export industries implies that a larger proportion of their productivity increment accrued to labor. This can be explained through the changes in the real prices of labor and capital. This is shown in Table VIII.. The real labor compensation per employee increased by 88.3 percent while the rate of return on capital rose by 25.5 percent between 1966

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[17]Out of 204 4-digit manufacturing industries 134 4-digit industries belong to the domestic sector.

Table V11

Labor Share of Income in Export, Import Substitution, and Domestic Industries

	1966	1967	1968	1969	1970
Export Industries	37.9	40.1	38.9	41.2	39.8
Import Substitution Industries	29.5	35.4	28.7	27.2	29.6
Domestic Industries	28.5	29.0	29.9	23.8	24.0
Total Manufacturing Industries	31.0	32.9	32.1	28.2	28.7

and 1970, with an average annual growth rate of 17.3[18] and 6.0 percent respectively. The rapid rise in real compensation per labor relative to real compensation of capital means that labor obtained a larger proportion of increase in output, with the result that labor share of income rose as compared with the base year period.

Although we have not calculated the real prices of labor and capital for other industries, it is clear from the above analysis that the rate of return on capital and real compensation per employee should have moved more or less parallel in import substitution industries because of constant factor shares of income in this sector between 1966 and 1970. In domestic and total manufacturing industries where a declining labor share of income is observed, the rate of return on capital should have risen much faster than the real compensation per employee.

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[18] In this connection, it should be noted that real labor compensation per employee, that is, the real wage rate rose faster than labor productivity during the period 1966-70. Labor productivity of the export sector as a whole rose, as already indicated, at an average annual rate of 13.8 percent, which is less than the growth rate of real compensation per employee. However, when current price labor compensation is deflated by All Urban Consumer Price Index, the growth rate of real wage rate (10.2%) is slightly lower than that of labor productivity. Even in this case, in a number of export industries the real wage rate rose faster than labor productivity between 1966 and 1970 (see Table III in the appendix).

Table VIII

Rate of Return on Capital and Real Compensation per Employes in Esport Industries

Year	Rate of return on capital (won) [1]	Index	Real compensation per employes (thousand won)	Index
1966	0.604	100.0	48.524	100.0
1967	0.636	105.4	54.857	113.1
1968	0.728	120.6	60.209	124.1
1969	0.755	125.1	76.375	157.4
1970	0.758	125.5	91.371	188.3
Average rate of change, 1966-70		(6.0)		(17.3)

1) Constant-price capital compensation divided by real capital stock (1968 capital stock series)

V. PRODUCTIVITY COMPARISONS BETWEEN EXPORT, IMPORT SUBSTITUTION, AND DOMESTIC INDUSTRIES.

1. Total Factor Productivity

Table IX shows the growth of total factor productivities in export, import substitution, and domestic industries during the period 1966-70. Two different figures for total productivity are shown, one based on the 1968 capital stock series, the other on the kilowatt electricity consumption.

It is remarkable that the growth rate of total factor productivity is in general much lower in the export sector than in either the import substitution or the domestic sector. In the case of unweighted total productivity based on the 1968 capital stock series, the highest productivity growth is observed in the import substitution sector, showing an average annual growth rate of 21.4 percent between 1966 and 1970. Relatively rapid productivity gains (14.2%) are also registered in the domestic sector, while the export sector, as already indicated, indicates the growth rate of 8.9 percent between 1966 and 1970.

The pattern of productivity growth among three sectors does not change substantially, even if we look at the weighted total factor productivity; the import substitution and domestic sectors show a higher productivity growth than the export sector. The only difference is that the productivity gains in the domestic sector (14.0%) are higher than in the import substitution sector (8.5%). This is due to the fact that the import substitution sector has undergone a rapid structural change, whereas in the domestic sector no such

Table IX

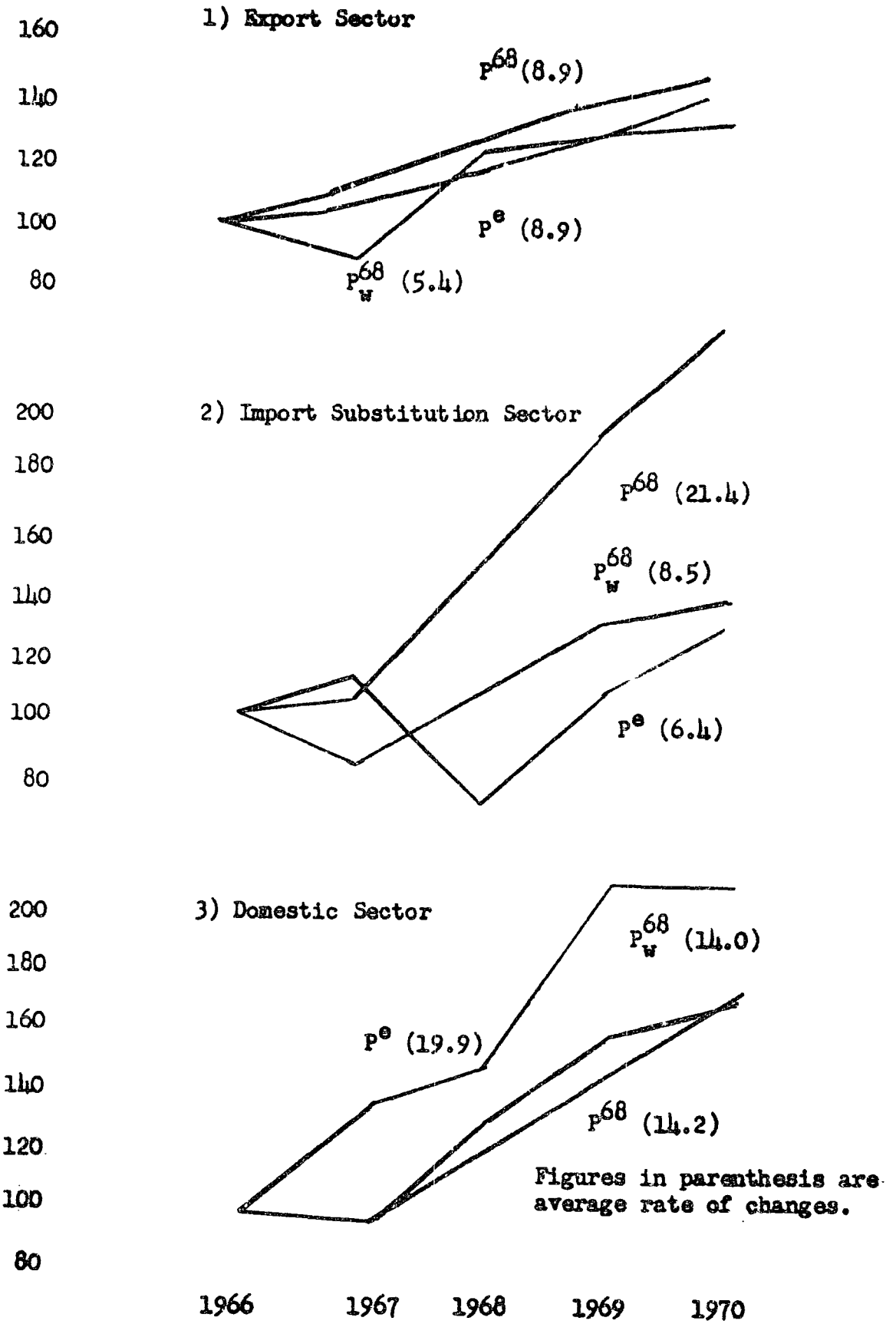
Total Factor Productivity Index for Export, Import Substitution, and Domestic Industries

	Export Industries			Import Substitution Industries			Domestic Industries		
	1) P^{68}	2) P_w^{68}	3) P^e	1) P^{68}	2) P_w^{68}	3) P^e	1) P^{68}	2) P_w^{68}	3) P^e
1966	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
67	105.5	101.0	86.4	103.5	82.0	110.6	92.9	93.9	131.4
68	120.7	112.6	117.3	140.9	102.1	88.7	121.3	126.3	144.3
69	131.6	120.7	120.6	185.1	123.7	101.9	143.5	151.1	201.4
70	140.5	123.4	133.4	219.2	131.4	122.0	165.3	163.3	198.9
Average Rate of Changes	8.9	5.4	8.9	21.4	8.5	6.4	14.2	14.0	19.9

1) Unweighted total factor productivity based on the 1968 capital stock series.
2) Weighted total factor productivity based on the 1968 capital stock series.
3) Based on slectricity consumption.

Figure I

Trends of Total Factor Productivities in Export, Import Substitution, and Domestic Sectors



structural change has taken place between 1966 and 1970. In other words, productivity gains in the import substitution sector are to a large extent attributable to the shift of resources from low to high productivity industries, while in the domestic sector productivity gains are almost entirely due to an increase in efficiency within the individual industries.

The low productivity growth in the export sector as compared with the import substitution and domestic sectors is verifiable at the industry level. As shown in Table X, most export industries indicate a low productivity growth as compared with import substitution and domestic industries except textiles, leather products, basic metal industries, and electrical machinery and apparatus. As far as productivity comparisons between import substitution and domestic industries are concerned, we find that in most cases import substitution industries show a higher productivity growth than domestic industries except clay and stone products and transport equipment. Although import substitution industries indicate a higher productivity growth in the same industrial group, over-all productivity gains were, as already noted, higher in the domestic sector than in the import substitution sector. This seems due to substantial productivity gains in such non-competitive industries as tobacco manufacture (58.7%), rubber products (18.1%), chemical products (20.1%), and petroleum (17.0%).

When we look at total factor productivity using electricity consumption, the domestic sector shows the highest productivity growth (19.9%), higher than the productivity growth based on the

Table X. Growth Rate of Total Factor Productivity in Export, Import Substitution, and Domestic Sectors

(in percentage changes)

Industrial Group	Export Sector			Import Substitution Sector			Domestic Sector		
	P^{68} 1)	P_w^{68} 2)	P^e 3)	P^{68} 1)	P^{68} 2)	P^e 3)	P^{68} 1)	P_w^{68} 2)	P^e 3)
20. Food manufacturing	9.0	12.0	3.0	34.5	34.5	27.1	19.4	15.6	30.5
21. Beverage industries	-	-	-	-	-	-	9.0	9.1	10.0 4)
22. Tobacco manufactures	-	-	-	-	-	-	58.7	58.7	-
23. Textiles	12.1	9.9	10.4	-	-	-	7.2	7.5	-22.4
24. Footwear, wearing apparel & made-up textile goods	6.0	6.2	-8.8	-	-	-	-	-	-
25. Wood & cork	-6.1	-8.7	12.0	-	-	-	1.7	1.6	4.0
26. Furniture & fixtures	-	-	-	-	-	-	7.7	7.7	-0.6
27. Paper & paper products	-	-	-	-	-	-	7.9	6.6	-9.5
28. Printing, publishing & allied industries	-	-	-	-	-	-	9.4	9.3	1.7
29. Leather & leather products	30.5	30.5	1.1	-	-	-	15.4	10.5	7.1
30. Rubber products	10.3	10.3	16.2	-	-	-	19.0	18.1	12.2
31. Chemicals & chemical products	-	-	-	29.6	26.3	-20.6	25.6	20.1	21.0
32. Petroleum & coal Products	-	-	-	-	-	-	12.1	17.0	45.4
33. Clay, glass & stone products	2.3	0.0	0.2	2.4	2.0	-7.7	9.8	9.7	12.1
34. Basic metal industries	7.1	7.1	26.0	7.4	3.7	3.0	-1.4	0.7	-13.0
35. Metal products	5.6	4.7	8.0	27.6	27.6	25.4	18.1	18.5	49.2
36. Machinery	-11.5	-11.6	8.3	8.3	8.7	11.0	-	-	-
37. Electrical machinery, apparatus & appliances	31.6	30.3	32.8	23.5	19.9	10.6	17.4	6.0	4.7
38. Transport equipment	-	-	-	17.4	4.4	16.3	15.0	15.4	9.6
39. Other manufacturing industries	14.2	9.5	-11.2	25.6	25.6	28.2	12.5	12.3	2.3
Total	8.9	5.4	8.9	21.4	8.5	6.4	14.2	14.0	19.0

1) Unweighted total factor productivity based on the 1968 capital stock series.
2) Weighted total factor productivity based on the 1968 capital stock series.
3) Based on electricity consumption.
4) Figures on electricity consumption are not available.

1968 capital stock series. By contrast, we observe that in the import substitution industries total productivity growth is much lower (6.4%) than one based on the real capital stock, implying that capital input in terms of electricity consumption is highly overestimated. For export industries we find the same productivity growth irrespective of different kinds of capital inputs used. In both cases, export industries show an average annual growth rate of 8.9 percent between 1966 and 1970.

In view of the large productivity differentials in the case of both import substitution and domestic industries, a question arises as to which total productivity index we should use as a measure of efficiency changes during the period 1966-70. We are inclined to use the total productivity index based on the 1968 capital stock series for the reasons that, firstly, electricity consumptions are indirectly estimated[19] and that, secondly, the estimated electricity consumption at industry level shows relatively large fluctuations over time. Furthermore, it is very doubtful whether electricity consumption can be regarded as indicative of the degree of mechanization because it is likely to be heavily dependent upon the technologies used.

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[19]Kilowatt electricity consumption at the 4-digit industry level are shown only in the Manufacturing Census of 1968, while in the remaining years information is available only in money terms. Using the 1968 census data we have calculated the unit price of electricity per kilowatt-hour. This is used to convert expenditures on electricity into kilowatt-hours for the remaining years. Electricity charges are not only different in different industries, but also non-proportional to electricity consumption. However, such problems are ignored in our estimate.

2. Capital Intensity

As Table XI shows, the import substitution and domestic sectors indicate a very high capital intensity as compared with the export sector. It is about three times as high in these sectors as the capital labor ratio in the export sector. By contrast, we find only a slight difference in capital intensity between the import substitution and domestic sectors.

The high capital labor ratio in the import substitution sector seems to reflect that import substitution industries are highly dependent upon advanced foreign technology, which is likely to be very capital intensive. The relatively high capital labor ratio in the domestic sector seems also to a large extent attributable to the imported technology in this sector because most of the domestic industries were initially import substitution industries relying heavily on the importation of advanced technology from abroad. Of course, imported technology has certainly played an important role in export industries such as textiles, but technologies introduced in export industries are relatively labor intensive so that they have not exerted any significant influence on the movement of capital intensity in export sector as a whole.

In this connection, it should be further noted that the increases in capital intensity in the import substitution and domestic sectors were much less than in export sector during the period 1966-70. In the case of the import substitution sector, we even find a slight decline in capital intensity. Nevertheless, labor productivity in two sectors rose much faster than in the export sector. Between 1966

Table XI

Capital-Labor Ratio in Export, Import Substitution, and Domestic Sectors

Year	Export Sector 1,000 won	Index	Import Substitution Sector 1,000 won	Index	Domestic Sector 1,000 won	Index
1966	167.00	100.0	567.32	100.0	436.24	100.0
1967	167.61	100.4	532.92	94.0	471.11	108.0
1968	171.70	102.8	514.34	90.7	469.22	107.6
1969	184.28	110.3	555.42	97.9	561.38	128.9
1970	220.54	132.1	554.60	97.9	552.38	126.6
Average Rate of Change, 1966-70		(7.5)		(-1.4)		(6.5)

1) Based on the 1968 capital stock series.

and 1970, labor productivity in the import substitution and domestic sectors rose at an average annual growth rates of 22.2 and 19.3 percent respectively, while in the export sector it rose at the rate of 13.8 percent per annum over the same period. Modern foreign technology coupled with the more efficient use of capital seem to have been the major sources of productivity growth in both the import substitution and domestic sectors.

3. Capital-Output Ratio

The high productivity growth in both the import substitution and domestic sectors during the period 1966-70 is reflected in a rapid decline in capital-output ratios during the same period.(see Table XII) According to Table XII, the capital-value added ratio in the import substitution sector has undergone a sharp decline between 1966 and 1970: it dropped from 1.594 in 1966 to 0.722 in 1970. A rapid decline in the capital-value added ratio is also observed in the domestic sector in which the capital-value added ratio fell from 1.268 in 1966 to 0.818 in 1970. Although a slight decrease in the capital-value added ratio is experienced in the export sector, the rate of decrease is much smaller than in the import substitution and domestic sectors.

It is remarkable that the capital-output ratio varied only a little among the three sectors. The capital-output ratio in the domestic and import substitution sectors was in the initial year somewhat higher than in export sector. Due to a rapid productivity growth in both sectors, however, the capital-output ratio of these two sectors was lower than that of export sector in the terminal

Table XII

Capital-Output Ratio in Export, Import Substitution, and Domestic Sectors

Year	Export Sector	Index	Import Substitution Sector	Index	Domestic Sector	Index
66	1.101	100.0	1.594	100.0	1.268	100.0
67	1.040	94.5	1.512	94.8	1.395	110.0
68	0.917	83.3	1.099	68.9	1.067	84.2
69	0.866	78.6	0.856	53.7	0.946	74.5
70	0.861	78.2	0.722	45.3	0.818	64.5
Average Rate of Change, 1966-70		(-5.8)		(-17.6)		(-9.6)

1) Based on the 1968 capital stock series.

year. This is particularly notable in view of the fact that capital intensity in the domestic and import substitution sectors was much higher than in export sector throughout the entire period, suggesting that the size of capital-output ratio cannot be judged by the degree of capital intensity.

VI. SUMMARY AND CONCLUDING REMARKS

Using the Korean Standard Industrial Classification, we have classified whole manufacturing industries existing between 1966 and 1970 into three different categories: export, import substitution, and domestic industries. Productivity is measured in terms of labor, capital, and total factor productivities for each sector of manufacturing industries. Inter-sectoral comparisons of productivities are also made in order to assess the export performance of the Korean economy in terms of efficiency of resources allocation during this period. Our findings can be summarized as follows:

1) The productivity growth of the export industries as a whole was very low as compared with their export performance. Total factor productivity based on the 1968 capital stock series, for example, showed an average annual growth rate of 8.9 percent, while exports grew at an average annual rate of 36.7 percent between 1966 and 1970. In other words, productivity growth explains only about 20 percent of export growth. The weighted total productivity growth is much lower (5.4 percent), implying that productivity gains are to a large extent attributable to structural changes within the export sector, i.e., the

shift of resources from less productive to more productive industries between 1966 and 1970.

2) Out of twelve export industries at the 2-digit level, the highest productivity growth was observed in electrical machinery and apparatus which showed an average annual growth rate of 31.6 percent between 1966 and 1970. Rapid productivity gains were also registered in such export industries as leather products (30.5%), other manufacturing industries (14.2%), textiles (12.1%), rubber products (10.3%), and food manufacturing (10.7%). All other industries indicate either low or negative productivity growth. Industries showing negative productivity growth were wood products (-6.1%) and machinery (-11.5%).

3) Export growth was highly correlated with output growth as compared with productivity growth. The coefficient of correlation between export and output growth was high for most of export industries except leather products, clay and stone products, metal and basic metal industries, and machinery, whereas a high correlation coefficient between export and productivity was observed only in several industries such as food manufacturing, textiles, rubber products, and electrical machinery and apparatus. These statistical results seem to demonstrate that productivity has not played any important role in over-all export performance of manufacturing industries during the period 1966-70.

4) As far as productivity comparisons among the export, import substitution, and domestic sectors are concerned, the export sector showed the least productivity growth among three sectors. Productivity

growth in import substitution sector was higher than in domestic sector in the case of unweighted total productivity, while in the case of weighted productivity the latter showed a higher growth rate than the former. This is due to the fact that the import substitution sector has undergone a rapid structural change whereas in the domestic sector no such structural change has taken place between 1966 and 1970.

The higher productivity growth in the import substitution and domestic sectors seems attributable to the superior foreign technology embodying a higher capital intensity. Capital intensity in both sectors is much higher than in the export sector. In spite of major differences in capital intensity, however, the capital-output ratio of the export sector in the initial year was slightly lower, whereas it was higher in the terminal year than import substitution and domestic sectors. This stems from rapid productivity gains in the import substitution as well as in the domestic sector. In this connection, it should be noted that there are a number of other factors favoring domestic and import substitution industries: the monopolistic position of some industries in the domestic market, economies of large scale and a higher level of efficiency resulting from competition. By contrast, most of the export industries are of small-scale and are equipped with primitive technologies. Furthermore, a variety of direct and indirect subsidies extended to export industries have distorted their investment decisions leading to excessive investment. A relatively rapid increase in capital intensity in the export sector seems to reflect this phenomenon.

5) The labor share of income in the export sector showed a slig upward trend between 1966 and 1970, while in the domestic sector it fell over the same period. In the import substitution sector, the labor share has remained very stable. Because of the dominant positi of the domestic sector, however, total manufacturing industries indicate a declining trend of the labor share between 1966 and 1970. This changing labor share over time suggests that the Korean manufacturing industries are not in a Cobb-Douglas world; a CES type of production function seems more appropriate, as far as production function analysis is concerned. Our estimate of the elasticity of substitution for export sector, which is less than one, confirms this contention.

Further, we note that in all three sectors the labor share of income is far below 50 percent. Among the three sectors, the export sector shows the highest labor share, reflecting the low capital intensity in this sector. Since the labor share of income is nothing but a unit labor cost, a rising labor share of income in the export sector implies that the burden of labor cost has increased considerably during the period 1966-70. We have already pointed out that in many export industries the real wage rate rose faster than labor productivity, although labor productivity in the export sector as a whole grew slightly faster than the real wage rate. The low productivity growth coupled with a rising unit labor cost seems to have deteriorated the financial position of these export industries.

We have demonstrated that the Korean export industries in general suffer from low productivity growth and rising labor cost as

compared with the industries oriented toward the domestic market. On the productivity side, however, there were a number of industries showing a high productivity growth such as electrical machinery and apparatus, leather and rubber products, and textiles, which are all labor intensive. At the moment, the comparative advantage doctrine seems working for Korea's labor-intensive industries, with the implication that a Heckscher-Ohlin type of factor intensity theorem is quite tenable. However, in view of the rising trend of labor cost, which is likely to accelerate in the future, steps are urgently needed to enhance labor productivity in these industries not only by means of introducing more advanced technology but also through on-the-job training, better management, etc.

The low productivity growth in the export sector is, as already noted, mainly due to low or negative productivity growth in capital intensive industries such as machinery, metal and wood products. Since these capital-intensive industries are mostly at the infant stage of development, we can not expect any substantial productivity improvements in the near future. Nevertheless, it seems imperative to develop intermediate and capital goods industries sharing an increasing portion of exports in the future. In addition to productivity improvements in existing export industries, further efforts should be made to diversify export industries by developing new commodities and new products for exports.

In a rapidly growing economy like Korea where resources are not fully utilized, it seems rather natural that in the initial stage of development productivity assumes a relatively less important role

as compared with factor inputs. A pattern of high economic growth heavily relying on increases in factor inputs, however, cannot be maintained in the long run because of increasing resource limitations. This is particularly true in the case of export industries, which in addition must cope with severe competition in the world market. It seems that the Korean export industries are through the initial stage of growth and gradually approaching a stage during which productivity growth will play a major role in export promotion. Therefore, the basic objective of future export promotion policies should be focused on productivity improvements in existing as well as in potential export industries.

DATA APPENDIX

Table I

Total Factor Productivity Index for Export Industries, 1966-70

Industrial Group	Year	p^{66} 1)	p^{68} 2)	P_w^{66} 3)	P_w^{68} 4)
Food manufacturing	66	100.0	100.0	100.0	100.0
	67	89.4	88.1	89.0	88.0
	68	93.5	91.5	94.8	93.1
	69	119.7	115.3	122.4	118.8
	70	150.0	144.0	155.3	150.3
Average Rate of Increase		(11.8)	(10.7)	(12.9)	(12.0)
Textiles	66	100.0	100.0	100.0	100.0
	67	116.9	119.5	114.8	115.2
	68	119.3	123.7	113.8	117.6
	69	144.4	153.1	135.2	143.6
	70	143.0	155.7	114.9	143.9
Average Rate of Increase		(10.3)	(12.1)	(4.4)	(9.9)
Footwear, wearing apparel & made-up textile goods	66	100.0	100.0	100.0	100.0
	67	122.2	125.6	120.3	126.4
	68	122.1	131.5	116.2	132.3
	69	106.5	119.6	98.9	120.7
	70	110.8	123.0	98.2	123.7
Average Rate of Increase		(3.4)	(6.0)	(0.3)	(6.2)

(Continued)

Industrial Group	Year	P^{66}	P^{68}	P_w^{66}	P_w^{68}
Wood products	66	100.0	100.0	100.0	100.0
	67	63.6	50.7	73.0	55.5
	68	118.5	70.0	113.4	77.3
	69	102.1	66.1	93.0	60.5
	70	102.0	61.1	92.8	55.9
Average Rate of Increase		(9.0)	(-6.1)	(2.5)	(-8.7)
Leather products	66	100.0	100.0	100.0	100.0
	67	60.8	61.4	60.8	61.4
	68	175.6	178.0	175.6	178.0
	69	121.3	128.8	121.3	128.8
	70	116.0	126.0	116.0	126.0
Average Rate of Increase		(28.6)	(30.5)	(28.6)	(30.5)
Rubber products	66	100.0	100.0	100.0	100.0
	67	117.6	107.6	117.2	110.1
	68	145.5	131.8	141.8	136.7
	69	145.5	125.9	138.9	128.5
	70	172.3	145.4	167.1	145.1
Average Rate of Increase		(14.9)	(10.3)	(14.1)	(10.3)

(Continued)

Industrial Group	Year	p^{66}	p^{68}	P_w^{66}	P_w^{68}
Clay, glass & stone products	66	100.0	100.0	100.0	100.0
	67	102.9	102.7	102.6	103.0
	68	45.4	45.2	43.9	45.0
	69	67.6	66.6	68.3	70.4
	70	78.8	76.7	54.0	68.1
Average Rate of Increase		(3.2)	(2.3)	(-5.0)	(0.0)
Basic metal	66	100.0	100.0	100.0	100.0
	67	27.9	27.0	27.9	27.0
	68	55.8	51.3	55.8	51.3
	69	71.2	62.4	71.2	62.4
	70	83.0	55.8	83.0	55.8
Average Rate of Increase		(18.0)	(7.1)	(18.0)	(7.1)
Metal products	66	100.0	100.0	100.0	100.0
	67	66.7	66.5	66.2	66.0
	68	82.3	81.8	81.5	81.1
	69	101.3	100.1	100.9	98.4
	70	112.5	110.6	111.4	106.8
Average Rate of Increase		(6.1)	(5.6)	(5.9)	(4.7)

(Continued)

Industrial Group	Year	p^{66}	p^{68}	P_W^{66}	P_W^{68}
Machinery	66	100.0	100.0	100.0	100.0
	67	72.8	68.7	72.5	68.5
	68	65.5	58.6	66.3	59.2
	69	90.9	78.0	91.2	78.1
	70	62.1	52.1	62.2	52.1
Average Rate of Increase		(-7.5)	(-11.5)	(-7.6)	(-11.6)
Electrical machinery, apparatus & appliances	66	100.0	100.0	100.0	100.0
	67	92.6	109.5	85.4	100.3
	68	118.7	169.1	110.1	157.2
	69	107.9	198.2	95.6	181.0
	70	138.6	287.5	123.1	269.2
Average Rate of Increase		(10.1)	(31.6)	(7.5)	(30.3)
Other manufacturing industries	66	100.0	100.0	100.0	100.0
	67	46.3	45.6	37.6	37.7
	68	85.2	90.7	73.5	73.6
	69	83.3	100.0	73.7	74.7
	70	90.3	101.6	76.7	77.3
Average Rate of Increase		(12.2)	(14.2)	(9.3)	(9.5)

(Continued)

Industrial Group	Year	P^{66}	P^{68}	P_W^{66}	P_W^{68}
Total export industries	66	100.0	100.0	100.0	100.0
	67	103.5	105.5	102.9	99.2
	68	117.0	120.7	114.0	110.7
	69	126.0	131.6	114.7	119.3
	70	132.7	140.5	108.8	122.8
Average Rate of Increase		(7.4)	(8.9)	(2.3)	(5.4)

1) Total factor productivity based on the 1966 capital stock series.

2) Total factor productivity based on the 1968 capital stock series.

3) Weighted total factor productivity based on the 1966 capital stock series.

4) Weighted total factor productivity based on the 1968 capital stock series.

Table II

Capital-Output Ratio and Capital Intensity
in Export Industries, 1966 - 1970

Industrial Group	Year	Capital Value Added Ratio				Capital Labor Ratio			
		K^{66}/V 1)	Index	K^{68}/V 2)	Index	K^{66}/L 3) (1,000 Won)	Index	K^{68}/L 4) (1,000 Won)	Index
Food Manufacturing	66	1.556	100.0	1.370	100.0	155.21	100.0	136.65	100.0
	67	1.940	124.0	1.742	127.1	222.66	143.5	199.96	146.3
	68	1.846	118.6	1.674	122.1	218.71	140.9	198.27	145.1
	69	1.467	94.2	1.357	99.0	233.40	150.4	216.01	158.1
	70	1.073	69.0	1.003	73.2	172.17	110.9	160.85	117.1
Average Rate of Increase			(-6.8)		(-5.4)		(5.5)		(7.2)
Textiles	66	1.175	100.0	1.426	100.0	163.68	100.0	198.54	100.0
	67	1.000	85.1	1.168	81.9	161.54	98.7	188.57	95.0
	68	0.977	83.2	1.114	78.1	160.55	98.1	183.01	92.2
	69	0.852	72.5	0.939	65.9	183.97	112.4	202.85	102.2
	70	0.930	79.1	0.991	69.5	229.51	140.2	244.74	123.3
Average Rate of Increase			(-5.2)		(-8.2)		(9.3)		(5.8)

(Continued)

Industrial Group	Year	Capital Value Added Ratio				Capital Labor Ratio			
		K^{66}/V	Index	K^{68}/V	Index	K^{66}/L	Index	K^{68}/L	Index
						(1,000 Won)		(1,000 Won)	
Footwear, wearing apparel & made-up textile goods	66	0.654	100.0	0.995	100.0	100.04	100.0	152.16	100.0
	67	0.473	72.4	0.684	68.7	73.71	73.7	106.51	70.0
	68	0.517	79.0	0.694	69.7	90.83	90.8	121.94	80.1
	69	0.609	93.1	0.763	76.7	97.55	97.5	122.33	80.4
	70	0.630	96.4	0.759	76.3	107.26	107.2	129.20	84.9
Average Rate of Increase			(0.7)		(-5.0)		(3.5)		(-2.3)
Wood Products	66	1.065	100.0	0.547	100.0	307.95	100.0	158.07	100.0
	67	1.696	159.2	1.196	218.7	528.78	171.7	372.94	235.9
	68	1.023	96.0	0.834	152.5	420.11	136.4	342.67	216.8
	69	1.221	114.6	1.063	194.3	391.70	127.2	340.93	215.7
	70	1.313	123.2	1.211	221.4	516.82	167.8	476.55	301.5
Average Rate of Increase			(11.6)		(32.4)		(19.0)		(41.7)

(Continued)

Industrial Group	Year	Capital Value Added Ratio				Capital Labor Ratio			
		K^{66}/V	Index	K^{68}/V	Index	K^{66}/L	Index	K^{68}/L	Index
						(1,000 Won)		(1,000 Won)	
Leather Products	66	0.630	100.0	0.841	100.0	130.77	100.0	174.60	100.0
	67	1.099	174.5	1.451	172.5	166.18	127.1	219.30	125.6
	68	0.317	50.3	0.414	49.2	88.03	67.3	115.03	65.9
	69	0.510	81.0	0.626	74.4	122.50	93.7	150.18	86.0
	70	0.510	81.0	0.602	71.6	105.65	80.8	124.73	71.4
Average Rate of Increase			(16.0)		(12.0)		(1.3)		(2.0)
Rubber Products	66	1.034	100.0	0.728	100.0	128.90	100.0	90.71	100.0
	67	0.973	94.1	0.753	103.4	163.27	126.7	126.27	139.2
	68	0.809	78.2	0.665	91.3	175.01	135.8	143.84	158.6
	69	0.893	86.3	0.772	106.1	232.56	180.4	201.09	221.7
	70	0.749	72.4	0.671	92.1	227.25	176.3	203.61	224.5
Average Rate of Increase			(-7.1)		(-1.3)		(16.1)		(23.5)

(Continued)

Industrial Group	Year	Capital Value Added Ratio				Capital Labor Ratio			
		K^{66}/V	Index	K^{68}/V	Index	K^{66}/L (1,000 Won)	Index	K^{68}/L (1,000 Won)	Index
Clay, glass and stone products	66	0.572	100.0	0.533	100.0	129.31	100.0	120.54	100.0
	67	0.415	72.6	0.388	72.8	62.60	48.4	58.52	48.6
	68	1.259	219.9	1.179	221.0	128.27	99.2	120.13	99.7
	69	0.833	154.3	0.793	148.6	123.21	95.3	117.25	97.3
	70	0.758	132.4	0.734	137.6	148.84	115.1	144.18	119.6
Average Rate of Increase			(33.1)		(34.0)		(17.5)		(18.5)
Basic metal industries	66	0.870	100.0	0.386	100.0	644.48	100.0	285.97	100.0
	67	4.215	484.5	1.950	505.1	2371.94	368.0	1097.15	383.7
	68	1.779	204.5	0.884	229.0	983.45	152.6	488.64	170.9
	69	1.514	174.0	0.792	205.2	1395.95	216.6	730.36	255.4
	70	1.345	154.6	0.951	246.3	1669.80	259.1	1180.44	412.8
Average Rate of Increase			(75.1)		(90.0)		(67.7)		(84.8)

(Continued)

Industrial Group	Year	Capital Value Added Ratio				Capital Labor Ratio			
		K^{66}/V	Index	K^{68}/V	Index	K^{66}/L	Index	K^{68}/L	Index
						(1,000 Won)		(1,000 Won)	
Metal Products	66	0.804	100.0	0.758	100.0	115.23	100.0	108.68	100.0
	67	1.325	164.9	1.255	165.6	152.96	132.7	144.92	133.4
	68	1.023	127.3	0.974	128.5	131.41	114.0	125.16	115.2
	69	0.889	110.6	0.853	112.5	162.64	141.1	156.07	143.6
	70	0.769	95.7	0.745	98.2	143.08	124.2	138.45	127.4
Average Rate of Increase			(3.8)		(4.5)		(7.5)		(8.2)
Machinery	66	0.784	100.0	0.516	100.0	170.01	100.0	112.00	100.0
	67	1.072	136.8	0.777	150.5	168.26	99.0	121.98	108.9
	68	1.361	173.7	1.051	203.7	242.32	142.5	187.18	167.1
	69	1.034	132.0	0.840	162.6	288.82	169.9	234.46	209.3
	70	1.624	207.3	1.337	259.1	378.40	222.6	311.60	278.2
Average Rate of Increase			(24.9)		(23.3)		(20.3)		(17.4)

(Continued)

Industrial Group	Year	Capital Value Added Ratio				Capital Labor Ratio			
		K^{66}/V	Index	K^{68}/L	Index	K^{66}/L (1,000 Won)	Index	K^{68}/L (1,000 Won)	Index
Electrical machinery, apparatus and appliances	66	0.532	100.0	1.900	100.0	91.89	100.0	328.51	100.0
	67	0.522	98.1	1.346	70.9	72.87	79.3	188.32	57.3
	68	0.472	88.8	0.907	47.7	105.91	115.3	203.56	62.0
	69	0.583	109.7	0.771	40.6	152.82	166.3	202.07	61.5
	70	0.493	92.8	0.601	31.6	214.58	233.5	261.36	79.6
Average Rate of Increase			(-0.8)		(-24.7)		(27.3)		(-1.4)
Other manufacturing industries	66	0.263	100.0	0.312	100.0	46.34	100.0	54.98	100.0
	67	0.638	242.9	0.772	247.9	69.65	150.3	84.36	153.4
	68	0.310	117.9	0.334	107.2	46.93	101.3	50.64	92.1
	69	0.323	123.0	0.335	107.7	49.81	107.5	51.75	94.1
	70	0.336	128.1	0.342	109.7	78.47	169.3	79.72	145.0
Average Rate of Increase			(24.9)		(23.3)		(20.3)		(17.4)

(Continued)

Industrial Group	Year	Capital Value Added Ratio				Capital Labor Ratio			
		K^{66}/V	Index	K^{68}/V	Index	K^{66}/L	Index	K^{68}/L	Index
						(1,000 Won)		(1,000 Won)	
Total export industries	66	0.982	100.0	1.101	100.0	150.31	100.0	168.56	100.0
	67	0.956	97.4	1.040	94.5	153.49	102.1	167.00	99.1
	68	0.859	87.5	0.917	83.3	160.11	106.5	170.96	101.4
	69	0.826	84.1	0.866	78.6	176.12	117.2	184.61	109.5
	70	0.834	85.0	0.861	78.2	213.15	141.8	220.00	130.5
Average Rate of Increase			(-3.9)		(-5.8)		(9.3)		(7.2)

1) Based on the 1966 capital stock series.
2) Based on the 1968 capital stock series.
3) Based on the 1966 capital stock series.
4) Based on the 1968 capital stock series.

Table III

Labor Productivity and Real Wage Rate in Export Industries

Industrial Group	Year	Labor Productivity	Real Wage Rate 1)	Real wage Rate 2)
Food manufacturing	1966	100.0	100.0	100.0
	1967	115.1	154.9	143.1
	1968	118.8	136.4	126.6
	1969	159.6	186.9	176.3
	1970	160.9	172.1	176.1
Average Rate of Increase		(13.4)	(20.7)	(17.7)
Textiles	1966	100.0	100.0	100.0
	1967	117.4	113.9	116.0
	1968	117.8	114.3	113.0
	1969	154.5	134.7	161.7
	1970	176.8	140.6	155.9
Average Rate of Increase		(15.9)	(6.6)	(13.2)
Footwear, wearing apparel & made-up textile goods	1966	100.0	100.0	100.0
	1967	101.8	108.0	105.8
	1968	114.9	139.1	127.6
	1969	104.8	139.0	132.5
	1970	113.3	142.3	141.0
Average Rate of Increase		(3.0)	(9.8)	(9.2)

(Continued)

Industrial Group	Year	Labor Productivity	Real Wage Rate 1)	Real Wage Rate 2)
Wood products	1966	100.0	100.0	100.0
	1967	107.9	109.7	117.8
	1968	142.1	102.5	118.6
	1969	111.0	127.3	163.7
	1970	136.2	123.6	159.9
Average Rate of Increase		(10.1)	(6.1)	(13.6)
Leather products	1966	100.0	100.0	100.0
	1967	72.8	106.7	119.5
	1968	133.8	121.6	152.8
	1969	115.6	139.3	197.6
	1970	99.8	126.7	208.5
Average Rate of Increase		(7.3)	(6.5)	(20.6)
Rubber products	1966	100.0	100.0	100.0
	1967	134.7	112.3	120.1
	1968	173.7	121.0	143.9
	1969	209.0	143.0	173.3
	1970	243.6	153.8	199.9
Average Rate of Increase		(25.1)	(11.4)	(18.9)

(Continued)

Industrial Group	Year	Labor Productivity	Real Wage Rate 1)	Real Wage Rate 2)
Clay, glass & stone products	1966	100.0	100.0	100.0
	1967	66.7	129.3	139.0
	1968	45.1	113.2	117.9
	1969	65.5	138.7	162.5
	1970	86.9	168.1	225.3
Average Rate of Increase		(3.1)	(8.6)	(25.1)
Basic metal industries	1966	100.0	100.0	100.0
	1967	76.0	167.6	188.6
	1968	74.6	125.0	156.4
	1969	124.5	150.9	195.4
	1970	167.6	243.7	292.2
Average Rate of Increase		(18.9)	(31.1)	(36.5)
Metal products	1966	100.0	100.0	100.0
	1967	80.5	101.0	115.1
	1968	89.6	88.5	101.2
	1969	127.6	136.6	167.6
	1970	130.0	149.1	193.5
Average Rate of Increase		(9.0)	(13.0)	(21.0)

(Continued)

Industrial Group	Year	Labor Productivity	Real Wage Rate 1)	Real Wage Rate 2)
Machinery	1966	100.0	100.0	100.0
	1967	72.3	99.3	100.7
	1968	82.1	135.4	131.5
	1969	128.7	157.6	156.8
	1970	107.4	153.8	150.1
Average Rate of Increase		(6.6)	(12.4)	(11.6)
Electrical machinery, apparatus & appliances	1966	100.0	100.0	100.0
	1967	80.9	113.8	108.4
	1968	129.8	159.4	150.6
	1969	151.6	127.6	145.3
	1970	251.6	174.8	230.1
Average Rate of Increase		(31.0)	(17.7)	(25.5)
Other manufacturing industries	1966	100.0	100.0	100.0
	1967	61.9	136.6	113.2
	1968	85.9	133.5	117.6
	1969	87.4	147.9	131.0
	1970	132.2	202.9	176.9
Average Rate of Increase		(13.4)	(20.5)	(15.9)

(Continued)

Industrial Group	Year	Labor Productivity	Real Wage Rate 1)	Real Wage Rate 2)
Total exports industries	1966	100.0	100.0	100.0
	1967	105.0	113.1	113.1
	1968	121.7	122.1	124.1
	1969	139.3	129.5	157.4
	1970	166.9	147.1	188.3
Average Rate of Increase		(13.8)	(10.2)	(17.3)

1) Deflated by All Urban Consumer Price Index

2) Deflated by Industrial Price Index

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INDUSTRY CONCENTRATION AND PERFORMANCE: KOREAN MANUFACTURING INDUSTRIES

Woo H. Nam

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PREFACE

This paper is one in the series of continuing KDI research works which is designed to aid in the formulation of sound public policies and to promote public understanding of major issues of the Korean Economy.

This paper is a part of our on-going research which will cover Korean industry structure, its changes in the course of industrialization, its effect on conduct and performance, and its welfare implications. The ultimate objective of this study is to provide clues to the formulation of anti-trust policies to promote competition and efficient allocation of scarce resources. It is hoped that this paper will help to stimulate the exchange of useful knowledge for the future improvement.

The interpretations and conclusions in this paper are those of the author or authors and do not represent the views of the Korea Development Institute itself. Finally, I would like to extend my appreciation to those within and outside of this Institute who have participated in these endeavours.

Mahn Je Kim
President

INDUSTRY CONCENTRATION AND PERFORMANCE: KOREAN MANUFACTURING INDUSTRIES

by

Woo H. Nam*

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I. INTRODUCTION

One of the pressing questions for the Korean economy in her process of industrialization is : How well do industries perform in the economy? What explains the good and bad features of their performance? How might we change public policy so as to build a better economy? The market performance, however, is a consequence of market behavior of the firms and industries, and market behavior, in turn, is heavily influenced by the market structure of industries which reflects the business environment. Therefore, the natural order of this study is;

1) to investigate the industry structure in terms of degree of concentration. The description of industry structure by the concentration index has two major advantages: (a) one can readily measure concentration in the actual industries, and (b) the seller concentration affects an industry's social performance - its contribution to the general economic welfare - in a vital way.

2) to evaluate the major factors that determine the level of concentration. Economic theory suggests that barriers to entry are the important determinant of concentration. This includes such things as scale-economy, large capital requirement, and absolute-cost barriers due to institutional or technical reasons. An attempt will be made to quantify the important determinants of concentration and estimate the relative significance of those factors. Extra attention will be paid to the role of foreign trade in order to reflect properly competition with imports and export promotion policy.

3) to uncover the reliable links between industry structure and the elements of performance of the market and of the nation's economy. The knowledge of the industry structure and its impact on the performance of the economy in terms of efficiency, growth, allocation of resources, price stability, and distribution, would help us to make public policy correctly tuned to get the best performance out of Korean industry. Korea has yet to develop anti-trust regulations to control monopoly and to promote competition.

The contents of this study will be subdivided into the following three sections. The measurement and selection of the concentration index will be made in section II. A brief discussion will be added on the behavior of concentration over time. Section III will discuss the major determinants of concentration, and quantitative estimates of these factors will be presented. In section IV, an attempt will be made to uncover the relationship between industry structure and the element of market performance. Special attention will be given to the examination of the joint effects of various dimensions of market structure upon profit rates among those indicators of market performance. Finally, some concluding remarks are made in the last section and some policy approaches to industrial concentration will be suggested.

The data set to be used for this study is taken from Mining and Manufacturing Census of 1966 through 1969 for the 4 year period. The analysis will be carried out for all 234 Census 4-digit industries of Korean Standard Industrial Classification. Supplementary information is to be drawn from a number of other official data sources.

II. MEASUREMENT OF CONCENTRATION

1. Choice of Concentration Index

In the past literatures, a variety of indexes of concentration have been used in the description and analysis of industrial structures. Basically, the argument is over the type of measure that can best be used to portray (1) the structure of an industry, (2) the structural differences between industries and (3) differences which occur in the structure of an industry through time. Since the review of the different kind of concentration indexes has appeared elsewhere[1], it will not be repeated in our study. Some comments, however, will follow.

Concentration, however measured, typically has been used as a measure or as a proxy which describes the extent to which the structure, and consequently the conduct and performance of an industry approximate competition or monopoly conditions. Basically, it measures the extent to which a small number of firms can exercise economic power over a market. The implicit assumption which underlies the development of a concentration measure is that monopoly performance is more likely when a large share of an industry's economic variables, i.e., assets, employment, sales, value added, productions, etc. is controlled by either a small number of firms or by a small proportion of the firms in an industry.

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[1] See Rosenbluth [18], Singer [19, Chapter 8 and 13], and Needham [17, Chapter 6].

The types of concentration indexes developed in the past can be classified into either relative concentration or absolute concentration measures.[2] The former considers the percentage of the total number of firms in an industry that control a certain percentage of the total assets or sales while the latter measures the proportion of total assets or sales controlled by a small number of very large firms in an industry.

The commonly used measures of relative concentration are the Lorenze curve and its modern-day varient of the Gini coefficient.[3] The Lorenze curve shows the percent of output accounted for by increasingly larger percentages of firms within an industry. The Gini coefficient is derived from the Lorenze curve and shows the share of total output that is accounted for by a small percentage of firms due to the inequality of distribution of firm sizes. Both Lorenze curve and Gini coefficient are based on the entire distribution of firms in an industry. Any changes in the distribution, rather than simply a change amongst the largest firms, will therefore be reflected in both of these measures. Thus it has the advantage of summarizing changes in concentration occuring throughout all classes rather than solely within the largest firms.

Others,[4] however, maintain that the proper object of study is fewness of sellers and that dispersion has no economic consequences.

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[2] The relative concentration measure is used as a synonym for inequality measures and is a summary index, while an absolute concentration is often expressed as a percentage index.

[3] See Lorenze [15], and the method is used in a number of studies on industrial concentration, and Gini coefficient is applied in A. Horowitz and I. Horowitz [11] and A. Kemp [12].

[4] For instance, see Adelman [3] and Balair [7].

In fact, it is the dominance of the few, quite apart from the number of sellers, which tends to influence the market. The more practical difficulty is that data on the individual sizes and number of firms which are a necessary ingredient of an inequality measure are only rarely available, whereas the total industry size together with the proportion contributed by the largest firms is now readily available through the Census of Manufactures. The fundamental controversy, therefore, is concerned with the concept of concentration which is more relevant to the study of market structure and for drawing inferences about industry behavior as well as with the practical problem of data availability.

Having considered both aspects for our study, we adopted the most commonly used measure, the absolute concentration ratio, which is the percentage of output or employment accounted for by the four and the eight largest firms in an industry. However, it should not be forgotten that the complete structure of an industry can not be described without knowledge of all firms in an industry. Moreover, regardless of which index one uses, the fact still remains that the measure is a single dimensional description of an industry structure while the industrial structure is multidimensional. Ideally, a full specification of all relevant structural characteristics of the industry in their degree of imperfection should be studied as well as concentration, i.e., the height of barriers to new entry, and the degree of product differentiation.

A few additional measure of concentration recently developed may deserve some comment. These include the studies by O. C. Herfindahl,[5] Hall and Tideman,[6] and Adelman.[7] Since the Hall-Tideman and Adelman indexes represent only slight variations of the basic Herfindahl index, a brief comment will be made on the Herfindahl index only.

The Herfindahl summary index[8] consists of the sum of squared firm sizes, all measured as a proportion of total industry size. Although this index is not derived from Lorenze curve, it is a measure of inequality of firm sizes or relative concentration. This index reaches its maximum value of unity when there is only one firm in an industry and is equal to the reciprocal of the number of firms if all firms are the same size.

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[5] See Herfindahl [10].

[6] Hall and Tideman [9].

[7] Adelman [2].

[8] The Herfindahl index takes the following form:

$$\text{H-index} = \sum_{i=1}^{n} (X_i)^2$$

where

n = number of firms in an industry, and

X_i = decimal fraction of output belonging to i-th firm.

The Hall and Tideman index is given as $\text{H-T index} = \frac{1}{2} \left(\sum_{i=1}^{n} r X_i \right) - 1$ where n and X_i are same as defined in H-index and r = industry rank of each firm. This formula is a simple variant of the H-index, weighting each firms share of industry output by its industry rank to give heavy stress on the absolute number of firms in an industry than on the relative sizes of firms.

Adelman adopts a somewhat different approach in that he is interested more in the effect of firm size upon the number of firms. His formula takes simply the reciprocal of the H-index.

Some empirical studies[9] have compared the ranking of concentration in different industries when using the Herfindahl index and the concentration ratio measures. The evidence suggests that the use of either of these two indexes would result in substantially the same ranking.

2. Measurement of Concentration Ratio

Besides the choice of concentration index, there are two additional important problems in the measurement of concentration. One is concerned with the definition of an industry. As the industry gets diversified, the problem of industry boundaries - boundaries between products in addition to boundaries in space and in time - poses great difficulty in the description of the market and industry. We had no other choice but to use the Korean Standard Industrial Classification due to the organization of the data as is usual in other studies.

Another important qualification for interpreting concentration ratios is the role of foreign trade. A single seller monopolizing the entire domestic market is a very different thing from a single domestic producer in competition with heavy imports of the same products. Such a problem is more serious where imports share much of the domestic market. Since Korean import duties on manufactured products have typically been high,[10] competition from foreign imports may comfortably be ignored. Extra attention, however, is paid to imports in the analysis.

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[9] See, for example, Rosenbluth [18].

[10] In 1968, the ratio between the sum of duties paid and total import value was found to be 15.4 and if we include duty exempted on

Four measures of concentration index for Korean manufacturing industries are computed based on the Census data for each year from 1966 to 1969. These are measured by the percentage of a) production and b) employment accounted for c) by the largest four firms and d) by the largest eight fir[11] The choice of the economic variables of production and employment are based on the availability of data. The results of concentration indexes are ranked according to the degree of imperfection and presented in Appendix I. Careful comparison among the different indexes reveals that while many industries change their positions in rank as the concentration index is changed, the general pattern remains the same. The similarity of pattern can be summarized by means of Spearman's rank correlation coefficients. The correlation coefficients for various pairs of rankings are as follows.

TABLE 1

(I-1) Rank Correlation Coefficients for 1966

	CRP_8	CRE_4	CRE_8
CRP_4	0.9710 (40.79)	0.8784 (18.47)	0.8732 (18.00)
CRP_8		0.8890 (19.50)	0.9023 (21.03)
CRE_4			0.9876 (63.16)

1. Figures in parentheses are t values.

non-commercial, this figure comes to 35.9 which reflects a high degree of protection.

11 Hereafter the concentration indexes measured in terms of production an employme are expressed by CRP and CRE respectively and four firm and eight firm concentration indexes are denoted by the subscription of 4 and 8, that is, CRP_4 and CRE_8.

(1-2) Rank Correlation Coefficients for 1967

	CRP_8	CRE_4	CRE_8
CRP_4	0.9743 (44.35)	0.8926 (20.21)	0.8918 (20.14)
CRP_8		0.9044 (21.68)	0.9203 (22.48)
CRE_4			0.9619 (35.98)

(1-3) Rank Correlation Coefficients for 1968

	CRP_8	CRE_4	CRE_8
CRP_4	0.9761 (46.01)	0.8892 (19.98)	0.8794 (18.92)
CRP_8		0.9077 (22.22)	0.9232 (24.63)
CRE_8			0.9843 (56.91)

(1-4) Rank Correlation Coefficients for 1969

	CRP_8	CRE_4	CRE_8
CRP_4	0.9676 (39.66)	0.8926 (20.48)	0.8849 (19.65)
CRP_8		0.9158 (23.58)	0.9332 (26.87)
CRE_4			0.9884 (67.36)

This reveals that regardless of level of aggregation i.e., 3 digit level or 4 digit level of industries, the correlation coefficients are all consistently high. It is, therefore, apparent that the ordering of industries by concentration level is largely independent of the particular index employed. This suggests that in the analysis of cross-section data, the use of any one of the indexes considered here would result in substantially the same implications.

3. Changes in Concentration over Time

It is of great interest for both policy-makers and economists to know 1) whether there has been a general trend in concentration levels, and 2) if so, what the underlying forces behind the trend are, and 3) what will be the future prospects. The investigation of these problem requires adequate length of time series statistical data. This study covers the 4 years from 1966 to 1969 due to data limitation. Hence, any results should be taken as indicative rather than conclusive.

The extent of the changes in concentration over time can be indicated in various ways. Firstly, if we take the concentration ratio of the median industry for each year, it shows a concentration ratio of 68.7 in 1966 and 75.3 for 4 digit industries in 1969 which is an increase of 9.5 percentage during this period. Alternatively, in terms of production, half of all production is from industries with a concentration of over 50 percent while the same proportion was produced by those industries with ratios over 40 percent in 1966, suggesting an increase in the overall concentration in 1969 over 1966. Thus it is

clear that the direction of change has been upward during the period considered.

To obtain the magnitude of changes in concentration between 1966 and 1969, we estimated the weighted average concentration indexes using output in each industry as weights. It is found that the weighted index of concentration is 49.7 for 1966 and 53.2 for 1969 which is an increase of slightly more than 3 percentage point in 1969 over 1966. This finding is a matter of considerable interest since there has been much speculation regarding the trend in concentration. The magnitude of change may not appear to be large, but its seriousness depends upon the persistency of the trend.

The increase in concentration is the result of changes either in concentration within industries or in the relative importance of different industries. The average change in concentration within industries can be measured by considering how the two weighted averages would compare if there had been no change in the relative size of different industries in terms of output. By giving the weights of the 1966 output level to both 1966 and 1969 concentration indexes, one can obtain the following annual average concentration ratio.

TABLE II

Annual Average Concentration Index
Weighted by 1966 Productions
(for 4 digit industries)

	1966	1967	1968	1969
CRP_4	49.81	49.61	48.09	48.49
CRP_8	61.03	61.17	61.09	61.58

This implies that when the relative sizes of industries are held constant at 1966 level, the concentration index did not increase at all. The increase in concentration rate between the two dates must, therefore, be due to the shift in the relative importance of different industries. This structural change of industries may be due to the rapid growth of particular industries through the introduction of new products, greater technical advances, and increase in plant capacity with foreign capital inflow. The rapid process of industrialization in itself may have brought about an increase in overall concentration. The lack of legal regulation against concentration may have been partially responsible for the upward trend. This trend towards concentration in order to restrict competition may be expected to remain more or less constant.

III. DETERMINANTS OF CONCENTRATION

This section will examine major factors influencing the level of concentration and estimate the quantitative significance of these factors using the cross-sectional data of 1968 because of the data limitation. Economic theory suggests that barriers to entry are the important determinant of concentration.[12] In general, this manifests itself in one or some combination of the following situations.

(1) Economies of scale are so important that an entrant would have to supply a substantial fraction of industry output in order to operate

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[12] See for detailed discussion on the determinants of concentration, Bain [5, Chapter 3-6].

at the minimum optimal scale of plant or of firm size. Entry at this scale would lead to excess capacity and either higher costs or a price war. The reduction of profits due to either of these eventualities discourages the entrant. (2) The established firms have built up product differentiation advantages which necessitate very large sales promotion outlays on the part of entrants in order to overcome the preferences for the leading firm's products. (3) The established firms may control scarce raw materials forcing entrants to use inferior supplies or to buy at prices above the competitive level from the going firms, have patent protection on superior production techniques which entrants can only obtain for royalty charges, have access to factors of production at lower prices than entrents must pay. All of these advantages of established firms mean that the entrant will operate at higher costs even if his scale of production realizes optimal efficiency. (4) The entrant may have to raise large amounts of capital, not only to build efficient plants or to acquire its own supplies of raw materials, but also to compensate for losses, possibly for a number of years, until profits are made. (5) The highly protective government policy for infant industries in the beginning of industrial development, to promote export and import substitution industries, should be noted. Each Five Year Development Plan of Korea stresses its importance for particular industries, i.e., the First FYP (1962-1966) for the key industries such as cement and fertilizer, and 2nd FYP (1967-1971) for the import substitution and export promotion industries. (6) Finally, not only are there the concentration-increasing forces described above, there are also the counter-vailing

forces which tend to check further increases in concentration. Besides legal constraints, one general factor working against an increase in concentration has been the largely sustained growth in demand.

On these grounds, the empirical analysis which follows takes the form of multivariate regression equations which explain the inter-industry variations in concentration ratio as a function of the following variables:

$Y = F (X_1, X_2, \ldots\ldots\ldots X_6; D_1 \ldots D_3)$

where

Y = the concentration ratio for i-th industry,

X_1 = the economies of scale,

X_2 = the intensity of advertisement,

X_3 = the absolute capital requirement,

X_4 = the policy dictated business financing,

X_5 = the growth rate of market demand,

D_1 = the import dependence of raw material; if 30 percent or more of total raw materials used are imported, it takes value of 1; otherwise zero,

D_2 = the export industry; if 30 percent or more of total industry products are exported, assign value of 1, otherwise zero, and

D_3 = The import substitute industry; if 30 percent or more of the total domestic consumption of the product of an industry is imported, assign value of 1, otherwise zero.

No attempt was made to measure any other absolute cost disadvantage of new entrants.[13]

Description and Definitions of Variables

A number of plausible explanatory variables may be suggested corresponding to theoretical counterparts. In this study we selected from these variables the ones with the best possibility of quantification. Other variables with considerable conceptual appeal such as patent have been excluded from the analysis due to the difficulties of quantification. Of the above[8] explanatory variables the last three are dummy variables to identify those industries engaged in foreign market transaction.

Y: The Concentration Ratio (%)

The average eight-firm concentration ratio derived in section II will be used. Since the Spearman Rank correlation between the different measures of index was very high, our empirical findings are unlikely to be sensitive to the choice of a specific concentration index.

X_1: Economies of Scale (millions of Wons)

We used average size of the firm as a measure of economies of scale. A ratio of real gross output of each industry and the number of manufacturing establishments in the same industry was used as a

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[13] The major difficulty is quantification of the variables. Also Bain found that only in those industries in which established firms controlled scarce natural resources were important. Bain [5, p. 155-156].

measure of average firm size in the regression equation.[14]

X_2: The Intensity of Advertisement (%)

It may be useful to examine the absolute values of advertising expenditures by existing firms as well as the advertising-sales ratio. Since the published data are available for the latter, we have used the advertising-sales ratio. This variable probably provides a good indication of the absolute cost disadvantage of the new entrant at small scale entry. The product differentiation through advertisement will be another barrier to entry.

X_3: The Capital Requirements (%)

The large amount of capital required for entry at the scale of a simple efficient plant creates barriers to entry. In this study, the capital-output ratio is used as a measure of the degree of capital requirement, and is expressed as a ratio between total tangible fixed capital and total gross output of each industry.[15]

X_4: Government Long-term Business Financing (%)

In a developing country where the private capital market is inadequate as a source of loanable funds, the role of government in

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[14] Economies of scale in production presumably exist primarily at the level of the plant rather than the firm. Therefore, our variable may be overestimated to the extent that there exists a multi-plant firm in the particular industry.

[15] This measure is likely on the average to underestimate capital requirements. The book value of total assets reported normally is less than their replacement cost, as a result of high inflation in preceding years. In addition, a new firm is likely to have higher input costs than the existing firms.

allocating scarce capital is a decisive factor as an indicator of institutional protection of a particular firm and industry.[16] In Korea, the long-term bank loans and foreign loans are mostly allocated by government policy. In order to capture this policy oriented protection, we introduced the government policy variable as a ratio between total long-term bank loans plus foreign loans and total liability by each industry.

X_5. The Growth Rate of Demand (%)

The rate of growth of demand used in our equation is measured by the average annual growth elasticity of output (sales) between 1966 and 1969.[17] Some emphasis is given to the long-run effects of the growth of demand by taking the average growth rate during this period. This variable is the only one in our equation that is expected to have negative influence on the concentration of the industry. An alternative measure of changes in demand is tried in terms of a ratio of percentage change in each industry's price index and wholesale price index of the manufactured goods. An industry with a greater increase in the demand for its product relative to other industries would have experienced a faster increase in the price of its product.[18]

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[16] Direct Tax advantages and other forms of subsidies may be other important variables.

[17] The growth elasticity of the i-th industry is defined as a ratio between the percentage change of output for the i-th industry and the percentage change in the aggregate output for the total manufacturing industry between 1966 and 1969. The ideal measure, of course, would be the rate at which the demand curve shifted over time.

[18] The results are reported in the appendix.

D_i: Industry Dummy Variables

These dummy variables are introduced to identify differences in concentration ratio among export industries, import substitute industries, and industries highly dependent on imported raw materials. In view of the scarcity of foreign exchange, import substitute industries are favorably treated under the protective government policy.

On the other hand, Korea in her rapid industrialization led by export growth has given the exporting industries a special right to import the major raw material and encouraged to operate at large scale to realize competitive advantage in the world market. This resulted in the formation of virtual monopolies in many of the exporting industries in the domestic market leading to price discrimination.[19]

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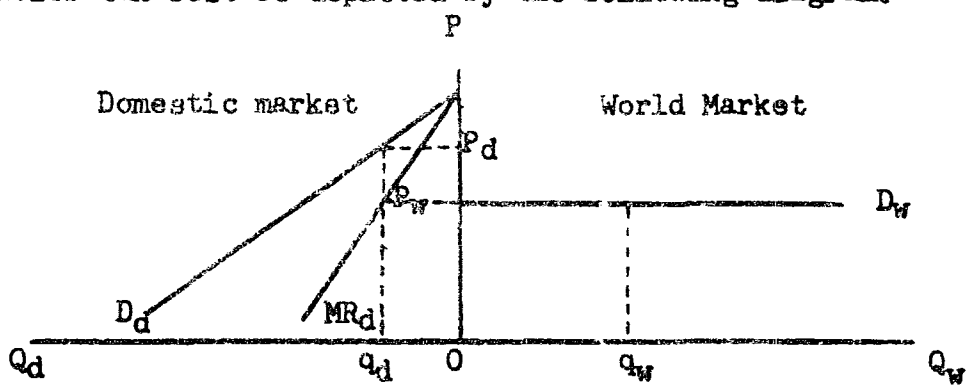
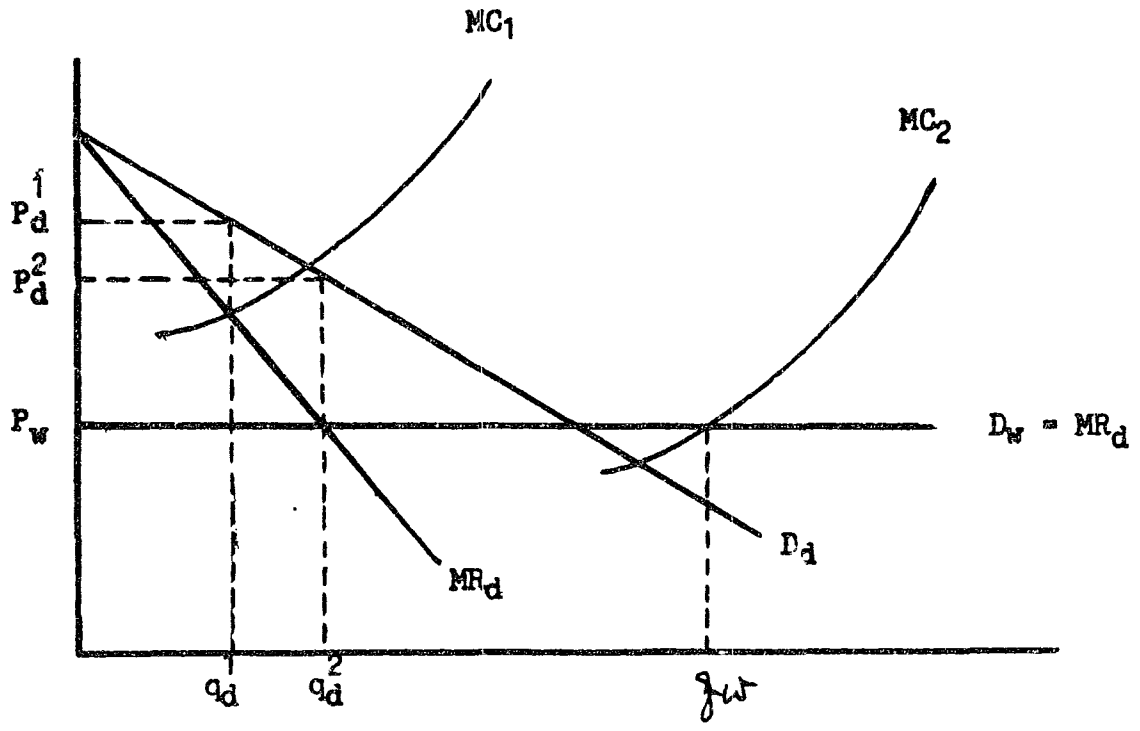
[19] It is often found that some of exporting industries practises price discrimination between the domestic market and the world market. This behavior can best be depicted by the following diagram.



Consider a hypothetical exporting industry A who is a monopoly in the domestic market while this producer is one of many suppliers in the world market. Then the profit maximizing firm will set the price level at $MC = MR_d = MR_w$ which is given by P_d in the domestic market and P_w in the world market. No doubt the domestic consumer pays higher prices than foreign consumer. Moreover, the export is made only after q_d is supplied for the domestic market to maximize profit. In the worst case the loss on exports can be made up from the excess profit from domestic market, as casual observations indicate. Combining both markets into one, we can introduce cost schedules for the following two different cases.

Regression Results

The results of regressions for the cross-section data of the 1968 Census are presented in TABLE III.



When monopolist has a cost curve of MC_1, no export is made with output and price being q_d^1 and P_d^1 in the domestic market. When the firm has MC_2, the quantity supplied and price are q_d^2 and P_d^2 in the domestic market and $q_w - q_d^2$ and P_w in the world market. The monopoly profit depends upon the average cost condition.

TABLE III

(III-1) Determinants of Concentration Ratio

Intercept	Economies of scale (~~logs~~)	Absolute capital requirement	Intensity of adbertisement	Gov't long-term business financing	Growth rate of demand	Import dependency of raw materials	Export industry	Import substitute industry	R^2	Corrected R^2
50.6992	0.0177		2.0208	0.1262	-4.0373	6.3043	18.9683	21.8867	0.718	0.362
	(3.2401)**		(1.2818)	(0.4163)	(-0.9690)	(0.5772)	(1.8218)*	(1.9252)**		
51.2683	0.0177	-0.5653	1.9746	0.1242	-3.9581	5.9841	18.7693	21.5341	0.718	
	(3.1502)**	(-0.0760)	(1.1400)	(0.3972)	(-0.8973)	(0.4986)	(1.7021)*	(1.7115)*		

1. Figures in parentheses are t value. The statistical significance of the regression coefficients is tested by means of one tailed t-test and of the multiple correlation coefficients by F ratio test.
2. * indicates coefficient is statistically significant at the 95 percent level.
   ** indicates coefficient is statistically significant at the 97.5 percent level.

(III-2) Determinants of Concentration Ratio

Intercept	Economies of scale (logs)	Absolute capital requirement	Intensity of adbertisement	Gov't long-term business financing	Growth rate of demand	Import dependency of raw materials	Export industry	Import substitute industry	R^2	Corrected R^2
14.7911	24.0300		0.7207	0.2008	-7.2713	10.5844	7.1362	18.6578	0.859**	0.655**
	(5.8980)**		(0.6150)	(0.9282)	(-2.3041)**	(1.3905)*	(0.9046)	(2.2401)**		
13.9245	24.0448	0.8501	0.7897	0.2033	-7.3958	11.0464	7.4290	19.1909	0.859**	0.637**
	(5.7380)**	(0.1557)*	(0.6151)	(0.9114)	(-2.2130)**	(1.3197)*	(0.8922)	(2.0807)**		

1. Figures in parentheses are t values. The statistical significance of the regression coefficients is tested by means of one tailed t-test and of the multiple correlation coefficients by the F ratio test.

2. * indicates coefficient is statistically significant at the 95 percent level.
** indicates coefficient is statistically significant at the 97.5 percent level.

Two formulations are fitted to the data: one is in linear and the other takes the economies of scale in logarithimic form. The results show that the signs of the coefficients of the explanatory variables are fairly consistent with a priori expectation except for the capital requirement variable. It appears that the variable describing economies of scale is the most important explanatory variable of the inter-industry concentration ratio. It is followed by the intensity of advertisement variable. None of the other explanatory variables are statistically significant except for the rate of growth in demand and the dummies of industry characteristics. Contrary to expectation, the capital requirement variable[20] is quite weak. Perhaps the poor showing may be due to faultiness in the data as footnoted in the previous page. For this reason, we have tried the same regressions dropping the capital requirement variable out of the equations. These results are reported in the same tables. General improvements are indicated in t-values for the estimates of all coefficients. It is undeniable that the data are far from ideal. It is interesting to note that import substitute industries are the most highly concentrated, followed by the export industries. Those industries are in general highly protected, perhaps technically more advanced, and are thereby in a superior position with respect to prospective entrants.

This empirical finding suggests that the increase in concentration ratio observed over time may have been mostly due to increase in firm

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[20] An alternative formulation replacing the capital requirement variable by labor productivity has also been tried on the ground that labor productivity would reflect capital intensity of an industry. No significant improvement was found.

size taking advantage of economies of scale[21] together with development of export and import substitute industries.

[21] The average firm size increased by 147 percent during four years (1966-1969) in terms of output and 32 percent in terms of employment. The following table shows the trend of the increase.

Firm Size

Years	1966	1967	1968	1969
Production (in 1000 won in 1965 constant prices	6874	8694	12506	16966
Employment	25	27	31	33

IV. CONCENTRATION AND MARKET PERFORMANCE

The market performance is the crucial indicator and measure of how well the market activities of firms contribute to the enhancement of general material welfare. The full appraisal of the market performance of industries, however, is difficult because performance is multi-dimensional and correspondingly complicated. That is, the particular set of performance variables which are analytically significant varies from industry to industry. Nevertheless, a certain few broad aspects of performance are important in all industries, for instance, the efficiency, the relation of price to cost as reflected in the profit rate, and the size of selling costs in relation to sales revenue. Except in a few instances, data of this kind is not readily available. Even where such details are available, however, it is not an easy matter to determine a priori how high the level of profits should be for firms in the industry or how sales promotion expenditure should be determined.

The purpose of the present section, therefore, is briefly to indicate some of the patterns of performance and to illustrate the extent to which measures of concentration are associated with various aspect of market performance, in particular, profitability. Amongst the important aspects of industrial performance are: allocative performance, relating to the long-run association between prices and marginal costs, as reflected in profit margins; promotional performance, which will be reflected in the ratio of selling costs to sales value; and technical performance relating to the extent that

products are manufactured in plants and firms of an efficient size.

1. Allocative Performance

Price theory gives its clearest prediction about one aspect of market performance, i.e., 'allocative' performance. One of its central conclusions is that the allocation of resources, when monopoly is present in some industries, is distorted since price will be above marginal cost, output will be restricted and long-run excess profits will be earned. This suggests that the higher the market concentration, the greater the likely divergence in the long-run between prices and marginal costs and this divergence is reflected in a long-run profit rate in excess of the 'normal' return on capital.

Two statistical approaches are utilized in this study to analyse the effect of the economic power (concentration) of the industry upon the profit rate which is the major performance indicator. The first is descriptive statistical analysis in the examination of the association which is likely to exist between profit rate and concentration in an industry. Secondly, a multivariate analysis is utilized to examine the joint effect of various dimensions of market structure upon the profit rate, thereby isolating the concentration effect net of other effects.

For the descriptive analysis, a dichotomous classification of concentration is constructed at the level of 70 percent following Bain.[22]

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[22] Bain found that a critical point was reached when the eight firm concentration ratio exceeded 70 percent. See Bain [6].

TABLE IV

(IV-1) Average Profit Rates for 56 Industries (for 1968)

Concentration Ratio	CRP_4		CRP_8	
	Net Profit to Gross Capital	Net Profit to Net Sales	Net Profit to Gross Capital	Net Profit to Net Sales
90 over	7.58	7.18	5.75	6.34
80 over	10.47	8.23	9.88	9.17
70 over	5.38	10.27	9.95	7.58
60 over	9.98	7.40	2.72	2.86
50 over	5.52	2.15	5.80	5.79
40 over	4.38	4.51	3.38	4.70
30 over	5.68	4.70	4.28	5.35
20 over	3.50	4.77	6.41	4.04
10 over	6.29	4.12		
70 over	6.42	8.45	5.83	7.19
70 below	4.04	4.40	4.20	4.72

TABLE IV

(IV-2) Averag. Profit Rates for 64 Industries (for 1969)

Concen-tration Ratio	CRP_4 Net Profit to Gross Captial	CRP_4 Net Profit to Net Sales	CRP_8 Net Profit to Gross Capital	CRP_8 Net Profit to Net Sales
90 over	4.48	5.27	4.70	6.47
80 over	4.98	8.77	6.24	6.18
70 over	10.03	8.76	6.92	5.58
60 over	7.52	5.72	4.95	6.07
50 over	4.21	4.48	3.60	3.89
40 over	5.65	5.63	0.59	0.95
30 over	1.06	1.34	5.61	4.79
20 over	0.77	1.22	4.93	2.78
10 over	0.68	0.65	0.18	0.18
70 over	5.12	6.44	3.58	4.14
70 below	3.64	4.21	3.43	3.09

The descriptive statistics of the profit rates in relation to concentration are shown in TABLE IV, using two different concepts of profit rates for 1968 and 1969. Taking a look at the table, there is a distinct differences between the average profit rates of two groups of industries, divided according to whether the concentration ratio for the top eight and four firms is greater or less than 70 percent. Regardless of year of observations, choice of concentration index and definition of profit used,[23] profit rates of the industries above 70 percent of concentration ratio are consistently higher than industries under 70 percent of concentration ratio without a single exception.[24] It is however, interesting to note that profit rates do not vary continuously and proportionally with the degree of concentration. The similar result was found by Bain for the U.S. data.[25]

Though the concentration is the most simple important indicator of market structure, a detailed study of a cross-section of industries which takes into account other major dimensions of market structure may be expected to provide a more satisfactory test of the relationship between the concentration level and profitability.[26]

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[23] The two different concepts of profit rates used in this table are taken from Korea Development Bank [14].

[24] This finding is consistent with Bain's study in which he found that there was a statistically significant difference in the average profit rates of the two classes for American industries (1950-1960). See Bain [6].

[25] See Bain [6].

[26] See for example, Comanor and Wilson [8].

besides concentration, the height of entry barriers and product differentiation are other major dimensions of industry structure. To examine the joint effects of those various dimensions of market structure upon the profit rate, the following equation will be formulated and fitted to the cross-sectional Census data for 1968.

$$P = F (X_1, X_2, \cdots X_5; D_1, D_2)$$

where

P = the profit rate,

X_1 = the concentration ratio,

X_2 = the economies of scale,

X_3 = the absolute capital requirement,

X_4 = the growth elasticity,

X_5 = the intensity of advertisement,

D_1 = if export industry, value of one; otherwise zero, and

D_2 = if import-substitute industry, value of one; otherwise zero.

The definitions and a brief rationale for the selection of each explanatory variable are as follows:

Profit Rates

The standard profit variable used in other studies is profit after taxes as a percentage of stockholder's equity[27] averaged within each industry for firms. Although the profit rate on stockholder's equity

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[27] This concept is originally used in J. Bain [6].

is viewed as a more appropriate variable, in this section we will use the rate of return (including interest) on total assets due to the data problem. The rate of return used in this study is defined as total sale minus total cost excluding interest divided by the total assets.

Independent Variables (Explanatory Variables)

Firstly, the major indicator of industry structure is the concentration ratio. The eight firm concentration ratio is used as a continuous variables in our equation.[29] Secondly, two explanatory variables are introduced into the equation in order to jointly represent the height of barriers which is another major dimension of market structure. They are respectively economies of scale and capital requirement which are used and defined in section III. Product differentiation, a third major dimension of market structure, is approximated by advertising expenditures[30] which are both a symptom and a source of differentiation. The intensity of advertisement variable defined and used in section III will be employed. The rate of growth in demand variable is added in terms of annual average growth

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28 Even though firm maximize profit rather than the rate of return which is the sum of profit and interest, in Korea this sum may not be the bad indicator since the financial structure of business firms has extremely high debt ratio and often the interest payments are being made within a family.

29 It may be interesting to introduce this variable in discontinuous form.

30 Production differentiation plays a dual role. It not only influence directly the character of competition among established firms, but also raises the height of entry barrier. In this study, however, we do not deal directly with product differentiation, but focus instead upon advertising expenditure.

elasticity of industry sales to pick up dynamic factors. The higher the rate of growth in demand, the more profit in short-run may be expected while this leads to more competition in the long-run. Besides these explanatory variables, two dummies are introduced into the equations to identify the differential impact of the export and the import substitute industry on the rate of return variation.

The results of computation are presented in the following TABLE V.

TABLE V

(V-1) The Rate of Return (4 Digit)

Intercept	Economies of scale X_1	Intensity of advertisement X_2	Absolute capital requirement X_3	Growth elasticity X_4	Concentration ratio (CRP_8) X_5	Export industry D_1	Import substitute industry D_2	R^2
0.4455	0.0005	0.1086	-0.0003	-0.0867	0.0027			0.589**
	(2.280)**	(2.071)**	(-1.484)	(-0.761)	(0.445)			
0.4287	0.0005	0.1023	-0.0003	-0.0986	0.0038	-0.2376		0.596**
	(2.181)**	(1.877)*	(-1.505)	(-0.836)	(0.581)	(-0.537)		
0.4252	0.0005	0.0991	-0.0003	-0.0942	0.0042	-0.2620	-0.0779	0.597**
	(2.105)**	(1.694)	(-1.479)	(-0.766)	(0.596)	(-0.555)	(-0.182)	

1. Figures in parenthesis are t values. The statistical significance of the regression coefficients is tested by means of a one tailed t-test and of the multiple correlation coefficients by the F ratio test.

2. * indicates coefficient is statistically significant at the 95 percent level.
** indicates coefficient is statistically significant at the 97.5 percent level.

(V-2) The Rate of Return (4 Digit)

Intercept	Economies of scale X_1	Intensity of advertisement X_2	Absolute capital requirement X_3	Growth elasticity X_4	Concentration ratio (CRP_4) X_5	Export industry D_1	Import substitute industry D_2	R^2
0.4453	0.0005	0.1107	-0.0003	-0.0827	0.0033			0.591
	(1.973)*	(2.118)**	(-1.361)	(-0.722)	(0.527)			
0.4512	0.0005	0.1054	-0.0003	-0.0933	0.0041	-0.2243		0.598*
	(1.882)*	(1.950)*	(-1.357)	(-0.789)	(0.627)	(-0.517)		
0.4496	0.0005	0.1020	-0.0003	-0.0876	0.0045	-0.2512	-0.0905	0.599**
	(1.789)*	(1.771)*	(-1.343)	(-0.708)	(0.648)	(-0.545)	(-0.211)	

1. Figures in parenthesis are t values. The statistical significance of the regression coefficients is tested by meaan of a one tailed t-test and of the multiple correlation coefficients by the F ratio test.

2. * indicates coefficient is statistically significant at the 95 percent level.
** indicates coefficient is statistically significant at the 97.5 percent level.

As may be observed, the measure of economies of scale and the advertising cost to sales ratio appears to be the most important explanatory factors and have the expected signs, indicating positive influences upon the rate of return. The estimated coefficient of concentration ratio is quite weak even though it has the expected sign. This suggests that the partial effect of concentration upon the rate of return may be relatively unimportant when it is introduced in conjunction with variables reflecting product differentiation, the height of barriers, and the rate of growth in demand.[31] This finding may be consistent with the results of descriptive analysis made previously that profit rates do not rise steadily in order of increasing concentration levels. The estimated results are invariant to the choice of particular measured of the concentration ratio. It is, however, surprising to find that the coefficient of the variable describing capital requirement has a negative sign contrary to some plausible theorizing even though it is statistically not very significant. This probably reflects the cost of over capacity currently observed in capital intensive industries in Korea.[32]

In an alternative formulation, two dummy variables, one for export industry and the other for import substitute industry, are added to each case. No significant changes in our general findings are observed, and the estimated coefficients of dummies are insignificant

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[31] Similar results were in Pain and Mann [4].

[32] In fact, it is found in the following section that highly concentrated industries are burdened with underutilized capacity.

statistically, suggesting that there is no difference between the profit rates of export and import-substitute industries and other industries. It is interesting to note that estimated coefficients are fairly stable.

2. Technical Performance (Efficiency)

Economic theory indicates that one of several consequences due to the lack of competition in highly concentrated industries is likely to affect the internal efficiency of the firms adversely because they are normally operating with chronic excess capacity. There is, however, a less agreement on the magnitude and direction of hypothesis. Rather it is sometimes augued that higher seller concentration may reflect the growth of firms to relatively large sizes, so that they are able to make use of available economies of scale. A similar waste of resources would result if firms in an industry were inefficiently too small in which case firms are in deficiency of capacity. Furthermore, it is argued that there is a positive association of R and D activities with regard to inputs and their productivity with increasing absolute and relative size of firm. In brief, theoretical indications on this point are indefinite and inconclusive and empirical evidence is badly needed. In what follows, we will test the hypothesis of an association between excess capacity and the market structure as represented by a average capacity utilization ratio and the concentration ratio of an industry, based on the classification of concentration of 70 percent following Bain's procedure. The results are shown in the following TABLE VI, using different measures of concentration for 1967 through 1969.

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[33] The issue of firm size and market structure in relation to innovation performance has received special attention recently. None of the result of empirical findings, however, are conclusive and definitive. See Markham [16] and Adams [1].

TABLE VI

Concentration and Capacity Utilization Ratio[34] of 49 Selected Manufacturing Industries (1967-1969)

Concentration Ratio	1967		1968		1969	
	CRP_4	CRP_8	CRP_4	CRP_8	CRP_4	CRP_8
70 over	66.46	68.20	68.19	69.44	70.22	70.73
70 below	69.12	67.53	71.13	70.81	73.29	75.63

The table shows that in nearly all cases the utilization ratio of industries with concentration ratio, above 70 percent is consistently lower than the industries under 70 percent. This finding is reasonably clear evidence of high excess capacity associated with the concentrated industries though it may be inconclusive being a single dimensional approach. This excess capacity may have contributed to the cost-push trend in Korean economy. The result would be either to shift this burden to the consumers in the form of higher prices or to lead to the bankruptcy of the firms when the products are price elastic.

Finally, considerable attention has been focused recently on what may be called the innovative performance of industries which leads to a saving in real resources in relation to firm size and market structure.[35] Another controversial aspect is the area of advertisement expenditure. No space for these subjects are allowed in our study, and we leave these topics to future research.

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[34] We have used the data on the utilization rate reported in Kim and Kwon [13].

V. CONCLUSION

We have investgated the market structure of Korean manufacturing industry in terms of degree of concentration. Various measures of concentration have been utilized and compared for different levels of industry aggregation. The comparison of the concentration in the overall market shows a slight increase between 1966 and 1969. The weighted index of concentration shows an increase of 3 percentage between 1966 and 1969. The magnitude of change may not appear to be large but its seriousness depends upon the persistency of the trend. The increase has mainly resulted from the changes in the relative importance of the different industries rather than changes in concentration within industries. Among the major factors that influence the level of concentration of industries, economies of scale has been found to be the most significant factor, followed by the advertisement sales ratio. Contrary to plausible theorizing, the capital requirement variable appears to be quite weak. The import-substitute industries and export industries are in general more concentrated than the others.

The degree of concentration is closely related to market performance. It is a measure of how well the market activities of firms contribute to the enhancement of general material welfare. Among the important aspects of industrial performance, price theory gives its clearst prediction about one aspect of market performance, i.e., 'allocative' performance. One of its central conclusions is that when monopoly is present, the allocation of resources is distorted since price will be above marginal cost, output will be restricted and

long-run excess profits will be earned. Based on the dichotomous classification of concentration at the level of 70 percent, it is found that profit rates of the industries above the 70 percent of concentration ratio are consistently higher than those of industries under the 70 percent concentration ratio. When we introduce other major dimensions of market structure in conjunction with concentration using multivariate analysis, the results show that the partial effect of concentration upon the profit rate is relatively unimportant. It is also interesting to find that the export industries and import-substitute industries, while their absolute concentration is higher than other industries, do not derive any excess profit, contrary to casual expectation. It should, however, be noted that there is clear evidence of higher excess capacity associated with concentrated industries which may have contributed to the cost-push trend.

Throughout this study, the reliability and availability of data has been the limiting factor. Thus the results of this study should be taken as indicative rather than conclusive until additional tests can be performed using a refined data set.

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A FORECASTING MODEL FOR REVENUE ESTIMATION OF DIRECT TAXES

Chong Kee Park

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PREFACE

This report is one in the series of continuing KDI research works designed to aid in the formulation of sound public policies and to promote public understanding of issues of the Korean economy.

The critical need for accurate forecasts of the prospective tax yields is being increasingly recognized, for revenue estimation is an integral part of the budgetary decision-making process. The purpose of this study is to explore a new method for making short-term projections of tax revenue yields in Korea. In this study, Chong Kee Par develops a tax forecasting model for direct taxes that is consistent with the structural characteristics of the Korea's tax system and the economy. A forecasting model for indirect taxes has been developed by Wan-Soon Kim in a seperate report. This study is an out-growth of research originally undertaken for the Budget Bureau of the Economic Planning Board in connection with the preparation of the forthcoming budget.

The interpretations and opinions in this report are those of the author and do not necessarily represent the views of the Korea Development Institute. Finally, I would like to extend my appreciation to those within and outside of this Institute who have so generously and kindly contributed to the work of KDI.

Mahn Je Kim
President

A FORECASTING MODEL FOR REVENUE ESTIMATION OF DIRECT TAXES

by

Chong Kee Park*

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* The author is grateful for the valuable comments and suggestions of the KDI staff including Mahn Je Kim and Heeyhon Song. Oh Yean La, Director of the Tax Systems Bureau in the Ministry of Finance, was helpful to the author in the discussion of both structural aspects of Korea's tax system and tax data problems. The author also wishes to acknowledge the research assistance that he received from Chan Kock Yun and Ho Yang.

I. INTRODUCTION

Every budget includes an estimate of anticipated revenues during the prospective budget year, and forecasts of the expected tax revenues are needed to aid in the formulation of budget policies. Forecasting tax yield is a highly involved process, subject to many uncertainties. This is particularly so in developing countries, where adequate and reliable basic economic statistics are lacking. Nevertheless, an accurate projection of tax yields is an important part of the budgetary decision making process. Advance information strengthens policy formulation, for it provides the decision maker more and better tools than otherwise. Errors both of over-estimating and of under-estimating the government revenues will undermine the efficient fiscal planning of the government.

Over-estimation of prospective tax revenues, for instance, may encourage the adoption of unrealistic public programs, and subsequently may result in inflationary methods of finance. The resulting crisis may also contribute to a greater conservative bias in the next estimating round. Under-estimation, on the other hand, may mean that the government program is being carried on at the level less than the optimum resources available. The major objective of short-run revenue forecasting is thus to determine the budget constraint of available revenues on expenditures in order to maintain a desirable expenditure-revenue relationship. Reliable estimates of tax revenues are also essential for the analysis of the economic impact of the government

budget.

In the past, revenue forecasts were often based on judgement and on simple extrapolation of a time trend. It is frequently assumed that the changes in tax revenues are roughly proportional to changes in GNP and the general price level. But this is obviously much too rough, and will doubtless yield erroneous results. The purposes of this study are to develop new methods of forecasting tax revenue yields and to present estimates of Korea's tax revenue for the budget years 1972 and 1973. Another purpose of this study is to present measures of the responsiveness of income taxes to changes in aggregate income. An attempt is made to develop a simple tax model that is consistent with the structural characteristics of the economy and the tax system. A primary use of this model is to prepare the tax revenue estimates required in budget and tax planning as well as to provide an efficient method of estimating the revenue effect of proposed legislative changes in the tax structure.

The remaining sections in this study are as follows: The second section briefly reviews historical trends in the basic tax yield series used in this study. The third section provides a general discussion of the tax forecasting method and the statistical techniques. The fourth section discusses the structural features and the estimated tax functions of individual tax components. The fourth and final section

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For a general description of the revenue forecasting methods used in Korean government, see Ted E. McHold, [4, pp. 47-52].

summarizes the estimated values of tax elasticity measures and of tax yields for 1972 and 1973 and discusses their implications.

II. TAX PERFORMANCE IN KOREA: HISTORICAL ANALYSIS

It is always important to look back before we look ahead. The decade of 1960's has witnessed a phenomenal growth in the collection of tax revenues in Korea. A longer-range view of the performance of the major taxes is presented in Appendix Table I. The total tax revenue of central government increased in money terms from a mere 25.0 billion won in 1960 to almost 420 billion won in 1971. This represents a nominal growth of nearly seventeen times in tax revenue available for new and improved services provided by the government. In comparison, the gross national product increased by 13 times during the same period. Thus, increases in the collection of tax revenue far out-stripped concurrent gains in GNP.

The modernization of the tax system and the improvements in the administrative enforcement process, especially since 1966 when the government set up a new Office of National Tax Administration, were mainly responsible for the sharp increases in tax revenues during this time period. As shown in Appendix Table II, which exhibits the pattern of growth in tax collections since 1960, the most rapid growth in total tax revenue was recorded in 1966 -- an amazing 62 percent. Since then, however, the rate of growth has been slowing down steadily. In 1971 the rate of increase was only 27 percent. This observation

appears to confirm the general feeling that the limits of increased tax revenue through administrative improvements are being reached.

A notable feature of the tax system in Korea is that income taxes (both personal and corporation income taxes) play a significant role in financing government outlays, currently providing 40 percent of central government's total tax revenue. Revenue yields from these two sources increased by a factor of 55 during the 1960-1971 period and accounted for more than 40 percent of the total increase in central government tax revenue during this period. A close examination of data in Appendix Table III reveals that the most dramatic gain in relative importance among individual tax sources was registered in corporation tax yields, which grew from 3.5 percent in 1960 to 13.6 percent of total tax revenues in 1971. Receipts from personal income taxes as a share of the total also increased significantly -- from 8.4 percent to almost 26 percent. This situation is contrary to that usually prevailing in most developing countries, where taxes on income and profits constitute only a small proportion of total tax receipts and indirect taxes such as commodity tax and customs duties tend to play more important role.

In Korea the commodity tax is much less important. Although the largest single source of tax revenue up until 1962, it shows a gradual decline in its fraction of all taxes from over 17 percent in 1960 to

less than 11 percent by 1971. Furthermore, it is of interest to note that customs duties in Korea account for only a small proportion of total tax revenue, in sharp contrast with most other developing countries which depend to a substantial extent for their tax revenue on customs duties. In Ecuador, to cite an instance, customs duties account for almost one-half of the total tax revenue. They account for 30 percent or more in nine other countries, including Ceylon and Thailand.[2] In Korea the relative importance of customs duties is much smaller and has declined from 21 percent in 1960 and 24 percent in 1962 to less than 13 percent by 1971.

Three aggregate measures are used to summarize Korea's tax behavior since 1960, and they are exhibited in Table 1. The summary measures are: 1)The average tax rate, which shows the "tax burden" measured by the ratio of total tax revenue to GNP; 2)the marginal tax rate, which measures the absolute won change in total tax revenue per won change in GNP; and 3)the tax elasticity, which shows the percent change in observed tax yields for a 1 percent change in GNP.[3] The latter two measures are mathematically related; the tax elasticity is the marginal tax rate divided by the average tax rate.

It is seen from Table 1 that although the overall tax ratio has increased from almost 12 percent in 1960 to 16 percent in 1971, there

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[2] Raja J. Chelliah, [7], pp. 270-17.

[3] This value measures the total relative increase in tax yields, whether resulting from economic growth, or changes in tax parameters, or improvements in administrative enforcement.

TABLE 1

SUMMARY TAX MEASURES, 1960-1971
(Amount in Billion Won)

Year	TOTAL TAX[a/] (T)	G N P	T / GNP	dT / dGNP	dT / T / dGNP / GNP
	(1)	(2)	(3)	(4)	(5)
1960	29.47	246.69	11.9%		
1961	28.44	296.82	9.6		
1962	37.66	348.58	10.8	17.8%	1.86
1963	43.26	487.96	8.9	4.0	0.37
1964	50.68	696.79	7.3	3.6	0.40
1965	69.47	805.85	8.6	17.2	2.36
1966	111.92	1032.04	10.8	18.8	2.17
1967	153.16	1242.35	12.3	19.6	1.80
1968	230.55	1575.65	14.6	23.2	1.88
1969	310.14	2047.11	15.2	16.9	1.15
1970	402.05	2545.92	15.8	18.4	1.21
1971	494.85	3112.68	15.9	16.4	1.04
1962-66 Average(First Five-Year Plan Period)			9.3	12.3	1.43
1967-71 Average(Second Five-Year Plan Period)			14.8	18.9	1.42

Sources: Tax data from Office of National Tax Administration, Statistical Yearbook of National Tax, (Seoul: November, 1971), pp. 26-7; and GNP data from Economic Planning Board, Major Economic Indicators: 1960-1971, (Seoul: November, 1971), p. 15.

a/Total tax revenue as used here refers to central government tax revenue including customs duties and monopoly profits plus local government tax revenue.

has been some variation in the ratio during the early 1960's.[4] Since 1964, however, the ratio reveals a steady increase, but at a declining rate, up until 1970. And no increase in the ratio is shown for 1971. The marginal tax rate determines how fast the average tax rate(or tax burden) rises in the context of an increase in GNP over time. It gives us an idea of the proportion of an increment in GNP that the government has been able to divert to the public sector. In Korea the behavior of this ratio is seen to have varied from as high as 23.2 percent in 1968 to only 3.6 percent in 1964. Finally, the measures of tax elasticity are shown in the last column of Table 1. The overall elasticity of total tax yields with respect to GNP was only 0.37 in 1963, as compared with 2.36 in 1965 and 2.17 in 1966. This means that a 1 percent change in GNP yielded only 0.4 percent increase in total tax revenue in 1963 and nearly 2.2 percent increase in 1966. A close examination of the data reveals, however, that the tax elasticity tended downward since 1966, reaching about 1 by 1971.

III. TAX REVENUE ESTIMATION: AN ELASTICITY APPROACH

Projections of tax yields are usually derived from aggregate income forecasts and a simple projection model such as:

$$T_t = T_{t-1}\left[1 + E_T \frac{dY}{Y_{t-1}}\right]$$

[4] This instability in the tax ratio results from three temporary taxes in effect only during this period. They are land income tax, education tax, and foreign exchange tax.

where T_t is the tax yield forecast for next year, T_{t-1} is the tax yield in the base year, and E_T is the elasticity of tax yield T with respect to aggregate income Y. This model will provide revenue estimates for some future year if anticipated changes in income aggregate are forecast reasonably accurately and if E_T is known. This model derives from a theoretical consideration that the tax yield is sensitive to economic activity and has a functional relationship with income. For our forecasting purposes, we will primarily rely on the elasticity method to derive a measure of the sensitivity of taxes with respect to aggregate income. The value of the elasticity coefficient E_T is implicitly estimated from an equation of the form

$$T = a + \sigma (Y)$$

where σ is the estimate of E_T in the logarithmic form of the above equation. Solving for the regression coefficient σ in this equation yields an average revenue-income elasticity coefficient that reflects the percentage change in revenue yields per one percent change in aggregate income over the pertinent time period.[5]

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[5] The income elasticity of a given tax may also be determined by the relationship between the marginal yield per unit of income in a given period and the average yield-income ratio in the previous period:

$$E_T = \frac{dT_t}{T_{t-1}} \Big/ \frac{dY_t}{Y_{t-1}} = \frac{dT_t}{dY_t} \Big/ \frac{T_{t-1}}{Y_{t-1}} = \frac{T_{m_t}}{T_{a_{t-1}}}$$

It is obvious from the above equation that as the marginal ratio(T_m) rises in relation to the initial average ratio(T_a), the elasticity(E_T) increases. In other words, as long as T_m exceeds T_a, the value of E_T will be greater than 1. Similarly, the larger the T_a, the less the elasticity coefficient for a given marginal ratio.

In the following section we present an econometric analysis in which the Office of National Tax Administration(ONTA) quarterly series on component tax yields is related to aggregate income, policy variable and other variables. The relation, based on the years 1965-1970, is estimated in each of three different ways: one relates the taxable base to aggregate income; the second relates tax yield to income; and the third, tax yields to average effective tax rates. Most empirical work has been done on income elasticity of tax yields. However, in this study we extend our analysis to the income elasticity of the tax base and the rate elasticity of tax yields. Since most taxes are levied on bases that respond to economic change, increases in aggregate income a business activity can be expected to produce automatic tax revenue inc without changes in tax parameters. Different tax bases vary widely in their response to changes in the level of economic activity. In most cases, however, a change in tax base will have more impact on its yiel than will a tax rate change.

The choice of the independent variables included in the equations is limited by several practical difficulties. Many types of national income statistics, such as personal income and corporate profits, are not available on a quarterly basis. Furthermore, the need to project the basic variables dictated that we limit the number of variables to be included in the equation. We had to rely on such variables whose future course of variation can be projected with reasonable accuracy. In view of the fact that our primary concern is projection rather than

establishing the relationship between revenue variables and other economic variables per se, we avoided including variables whose future courses of change are very difficult to foresee, even if they are theoretically quite relevant.[6]

The choice of the form of the estimating equation is determined in the light of two criteria. First, the choice is made according to the goodness of fit to the observed data. The goodness of fit is usually represented by the coefficient of determination denoted by R^2 and is given for each of the estimating equations shown. Secondly, the choice is made on the basis of theoretical justifications(or of empirically tested hypotheses). If the relationship to be examined is considered to be one of a given percentage change in one variable associated with a corresponding change in the other variable, logarithmic forms of the equation are preferred.

In discussing time series data, we need to separate the revenue effects of price changes from the effects of real changes in income and production. Whereas the real value of tax yield will rise if the growth of income is due to rising output, the real yield will fall or remain unchanged if the income change is due to a rise in price level. It is generally agreed that the appreciation of taxable income that reflects an increase in the general price level must be excluded from

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[6] Estimates of independent variables used in the forecasting equations are based on forecasts derived from the quarterly projection model by Heeyhon Song , [8].

the tax base.[7] In order to eliminate the effect of price increases from our analysis, all variables in the estimating equations are expressed in real terms. All tax revenue series were uniformly deflated by the wholesale price index.

IV. THE ESTIMATING EQUATIONS

1. Personal Income Tax

The personal income tax is the most productive revenue source of the government in Korea, currently providing over a fourth of total tax revenue. The growth has been steady and remarkable. On a per capita basis, tax yields increased from less than 90 won in 1960 to nearly 2,700 won in 1970. The tax absorbed over 4 percent of personal income in 1970, rising from only 1 percent in 1960.

The basic feature of the Korea's personal income tax is the schedular tax system which provides the independent determination of taxable income and of the tax liability under each applicable rate schedule. Different income tax rates are applied to five separate groups of income: 1)wages and salaries; 2)business income; 3)real estate income; 4)dividend and interest, and 5)income from other miscellaneous sources. A graduate rate schedule is applied against wages and salaries, business income, and real property income. Table 2 presents the personal income tax rate schedule which became effective as a result of the tax reform of 1971,

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[7] Richard A. Musgrave, [1959, pp. 168-9]

TABLE 2

PERSONAL INCOME TAX RATES,
BY TAYPES OF INCOME

(EFFECTIVE 1972)

INCOME BRACKET (Annual Income in Thousand Wons)	TAXABLE Income a/			
	Wage & Salary	Real Estate & Business	Dividend & Interest	Other Income b/
120 or less	7%	-		
In Excess of 120	9	-		
In Excess of 240	12	-		
300 or less	-	15%		
In Excess of 300	-	20		
In Excess of 480	15	-		
In Excess of 600	-	28		
In Excess of 720	19	-		
In Excess of 960	25	-		
In Excess of 1,200	32	-		
In Excess of 1,400	-	38		
In Excess of 1,800	40	-		
In Excess of 2,400	48	-		
In Excess of 3,000	-	48		
Flat Rate			20%	20%

a/ In addition, a global income tax is levied on top of schedular structure if income from all sources combined exceeds 3 million won a year.

b/ Refers to miscellaneous income such as bonuses, prizes, and rewards.

TABLE 3

PERSONAL INCOME TAX RATES FOR WAGE AND SALARY INCOME, 1971 and 1972

INCOME BRACKET (Annual Income in Thousand Wons)	1971	1972
120 or less	7.7%	7%
In Excess of 120	9.9	9
In Excess of 240	12.1	12
In Excess of 360	15.4	-
In Excess of 480	-	15
In Excess of 720	22.0	19
In Excess of 960	29.7	25
In Excess of 1,200	37.4	32
In Excess of 1,800	46.2	40
In Excess of 2,400	55.0	48

and Table 3 compares the wage and salary income tax rate structures in effect before and after the tax reform.

The projection of the personal income tax was achieved in two separate steps. Because of the complex and graduated nature of the rate structure and the frequent rate adjustments which took place in the past, we chose for our estimating equation the volume of the taxable base rather than tax yields as the dependent variable. Thus we first projected the tax base separately for different income schedules using the time-series quarterly data from 1965 I to 1970 IV as a frame of reference. Effective tax rates for each income group were also derived from relating tax revenues to their respective tax base. Applying such a tax rate for a current year to the associated tax base for the next year resulted in an estimate of tax revenue due primarily to changes in tax base.[8] In projecting the tax revenue for the next year, it was assumed that the tax rate structure effective in 1972 will be maintained through the next budget year. We thus concentrate on the changes in tax yield that result while the tax parameters(statutory rates of tax) are held constant. The general procedure may be outlined as follows:

$$r_{t-1} = T_{t-1} \Big/ TB_{t-1}$$

$$T_t = TB_t \cdot r_{t-1}$$

where: r = implicit tax rate
T = tax yield
TB = taxable income(or base)

[8] The tax base as defined here refers to the net taxable income which is the difference between gross income and statutory allowances.

List of Variables

E_{NA} = Number of non-agricultural employment

r_p = Average effective tax rate for personal income tax

r_{PW} = Average effective tax rate for wage and salary income

r_C = Average effective tax rate for corporation income tax

T_p = Tax yield from personal income tax

T_{PW} = Tax yield from wage and salary income tax

T_C = Tax yield from corporation income tax

T_{AR} = Tax yield from assets revaluation tax

T_{GH} = Tax yield from gift and inheritance tax

T_R = Tax yield from registration tax

TB_p = Taxable base of personal income tax

TB_{PW} = Taxable base of wage and salary income

TB_{PBR} = Taxable base of business and real property tax

TB_{PDI} = Taxable base of dividend and interest income

TB_C = Taxable base of corporation income tax

Y_{NA} = Amount of non-agricultural GNP

Values of T, TB, and Y_{NA} in estimating equations are all measured in 1965 constant prices.

The relation between taxable base and aggregate income was measured by log linear regressions of the following type:

1. $\text{Log } TB_p = -12.8488 + \underset{(0.0625)}{1.9721} \log Y_{NA}$

$R^2 = .977 \quad D.W. = 2.44$

2. $\text{Log } TB_{FW} = -14.6281 + \underset{(0.1233)}{1.7828} \log Y_{NA} + \underset{(0.2745)}{0.4519} \log E_{NA}$

$R^2 = .980 \quad D.W. = 1.71$

3. $\text{Log } TB_{PBR} = -12.1322 + \underset{(0.2374)}{1.7675} \log Y_{NA}$

$R^2 = .705 \quad D.W. = [illegible]$

4. $\text{Log } TB_{PDI} = -22.6640 + \underset{(0.1834)}{2.5750} \log Y_{NA}$

$R^2 = .895 \quad D.W. = 1.32$

As is evident from equations shown above, all of the tax base elasticity coefficients(E_b) are very high and most equations indicate rather good fit to the observed data. The numbers in parantheses under the estimated elasticity coefficients are their respective estimated standard errors. R^2 is the coefficient of determination adjusted for degrees of freedom, and D.W. is the Durbin-Watson test statistic for serial correlation in the residuals.

It is to be noted that a regression coefficient in our equations measures the percentage change in tax base for each percentage change

in the independent variable, i.e., non-agricultural GNP(Y_{NA}). The regression coefficient of 1.7828 in equation (2), for instance, demonstrates that during the 1965-1970 period, the taxable base for wages and salaries increased an average of approximately 18 percent for each increase of 10 percent in Y_{NA}.[9] It may be concluded from such an estimate that the personal income tax base has a high degree of responsiveness to changes in aggregate income as one should expect. In particular, the value of E_b in the case of dividend and interest income(TB_{PDI}) in equation (4) is very high. The results obtained conform to an established theoretical view that as aggregate income rises the taxable income of the tax rises more rapidly. The faster rise in taxable income is due to the fact that when incomes are rising, more persons are moving from exempt status(a zero-rate bracket) to taxable status(a positive-rate bracket). Under the perso income tax with a graduated rate structure like Korea, the increase in income would push many persons into higher-rate brackets. Hence more aggr gate income moves into the taxable base.

The values of the tax base thus derived from these elasticity coefficients combined with an effective tax rates for 1972 yields the forecast of future tax yields. It should be noted, however, that since the elasticity coefficients derived from our estimating equations represent an average of the E_b 's for the 24 observations selected from the 1965 I-

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[9] It is quite interesting to note that this estimate of E_b=1.8 for Korea is somewhat higher than the base-elasticity coefficient of personal income tax of 1.5 for Japan. See Hiromitsu Ishi, [3, pp. 45-63].

1970 IV period reflecting the exceptionally high values of E_b for the mid-1960's, we needed to make in certain cases downward adjustments to estimated tax yields. In order to check the reasonableness of our initial estimate of total taxable income derived by aggregating values of the TB of individual component income groups, we have also estimated independently the total tax base of personal income tax using equation (1) above.[10] The result shows two totals differing by about 2 percent.

As a final step, tax yields thus derived have been modified to take account of revenue effects of the new tax law which became effective beginning 1972. Major changes in the tax provision include increases in the basic exemption levels for business and employment income (from 10,000 won per month in 1971 to 15,000 won per month in 1972) and reductions in the statutory tax rate. (See Table 3) The Ministry of Finance has estimated that the revenue loss resulting from these changes in the tax code would amount to about 22 billion won for 1972. Since 1969, a global income tax has also been levied on top of schedular

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[10] The following alternative equation gives the elasticity coefficients of the personal income tax yield using non-agricultural GNP and tax rate changes as the explanatory variables:

$$\text{Log } T_P = -17.5301 + \underset{(0.0659)}{1.9636} \log Y_{NA} + \underset{(0.1514)}{1.0735} \log r_p$$

$$R^2 = .980 \quad D.W. = 2.25$$

This equation indicates that the overall personal income tax yield is highly responsive to changes in the level of aggregate income(E_T=1.9636) and the rate-revenue elasticity coefficient at 1.0735 equals unity. The estimated values of coefficients seem consistent with theoretical knowledge on the subject.

structure if income from all sources combined exceeds a specified amount per year -- 3 million won in 1972. For our purpose of revenue estimation, this tax component plus miscellaneous income such as bonuses, prizes, and rewards has been derived as a residual.[11] In other words, it has been estimated as a function of total tax yield from schedular system

$$T_G = T_P - (T_{PW} + T_{PBR} + T_{PDI})$$

where: T_G = global income tax yield

T_P = total personal income tax yield

T_{PW} = yield from wages and salaries

T_{PBR} = yield from business and real property income

T_{PDI} = yield from dividend and interest income

2. Corporation Income Tax

The corporation income tax is the third largest source of central government tax revenue in Korea, currently providing about 14 percent of total tax revenue. Up until 1960, however, the tax on corporation income provided less than 4 percent of total tax revenue. In absolute amount, the tax intake rose from 0.9 billion in 1960 to 56.7 billion by 1971.

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[11] The tax yield from these two sub-groups amounted to only 5.8 billion won in 1971, representing less than 5 percent of total personal income tax revenue.

The tax is levied on the regular income earned by corporate taxpayers during each accounting period as well as on liquidation income. The corporation tax law provides three stages of tax rates in order to give small and medium size firms a lighter tax burden. In addition, a reduced rate applies to the income of non-profit corporations and open corporations.

TABLE 4

CORPORATION INCOME TAX RATE, EFFECTIVE 1972

INCOME BRACKET	Profit-Making Corporation	Open Corporation	Non-Profit Corporation
One Million Won or Less	20%	16%	20%
In Excess of One Million Won	30	20	30
In Excess of Five Million Won	40	27	35

Although the tax rate varies considerably according to the level of income and the type of corporation, over 90 percent of corporate taxable income is subject to the top rate bracket of 5 million won or more.

Because of the volatility of corporate profits, the corporate income tax is the most difficult component of government revenues to estimate. Payment of the tax rarely coincides with the timing of tax liability. The question of time lags is thus very important in

the collection of corporate income tax. Because of the collection lags, the tax behavior reveals a slower response to income accruals and tax yields usually lag a few months behind the variation in income. This factor has been taken into account in the equation for corporation income tax, using an average lag of one-quarter of a year.

A forecasting procedure suggested for corporation income tax is to make our estimating equation a multiple regression equation in which non-agricultural GNP and the average tax rate are independent variables. The rate variable is inserted into the estimating equation in order to test the revenue effects of changes in tax rates.[12]

$$4.\ \text{Log } T_{C(t)} = -13.5204 + \underset{(0.3944)}{1.6402} \log Y_{NA(t-\frac{1}{4})} + \underset{(0.6440)}{0.5257} \log r_C$$

$$R^2 = 0.858 \qquad D.W. = 2.46$$

As equation (4) above indicates, tax yields from corporate profits depend on aggregate income and the average tax rate. It will be seen from the equation that the value of the income elasticity for the corporation income tax at 1.6402 is quite high, and that the fit as indicated by the coefficient of determination is fairly good.[13] However, the rate elasticity coefficient of corporation income tax at 0.53 is very low and not significant. This seems to suggest that increases in

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[12] For a general discussion of the method of estimating rate elasticity, see, among others, Walton Perry Wilford, [11, pp. 304-127.

[13] This value of $E_T = 1.6402$ for Korea's corporate income tax compares with an income elasticity of 1.4619 for the corporation tax in Japan, see Ishi, [3, p.54]

tax yields from Korea's corporation income tax are a consequence primarily of increases in aggregate income rather than of changes in tax rate. This result is consistent with the established view regarding the effect of broadening the tax base. As Professor Richard A. Musgrave stated:

> The primary need is for measures which will secure a fuller coverage in assessment of the tax bases(be it income, sales or property values) under the various taxes. As compared to this, increases in tax rates are less important. Not only are they less significant from a revenue point of view, but primary attention to fuller coverage of the base comes first. [14]

3. Other Direct Taxes

Direct taxes other than income taxes(both personal and corporate income taxes) accounted for only 3.7 percent of total tax revenue of the Korean government in 1971, and is thus insignificant from a revenue point of view. These taxes include registration tax, gift and inheritance tax, assets revaluation tax, and real estate speculation control tax. Among these the registration tax is by far the most important, and tax yields from this source have been rising steadily over the past decade and currently account for 2.7 percent of all central government tax receipts. This proportion of 2.7 percent compares with a little over 1 percent in early 1960's.

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[14] Richard A. Musgrave, [5, p. 11].

The registration tax is levied on the registration of official books or documents relating to acquisition, creation, transfer, alteration, etc., of rights. The tax is also imposed on the registration of certain professional workers in connection with their qualification for general practice. Tax receipts from this source are, therefore, a conglomerate of various sources. However, the taxable registration of real properties account for the major portion of tax base.

The following equation gives the results of regressing changes in the yield of the registration tax on changes in non-agricultural GNP:

$$5.\ \text{Log } T_R = -15.9596 + \underset{(0.1149)}{1.8544} \log Y_{NA}$$

$$R^2 = .919 \qquad D.W. = 2.04$$

The above equation shows an income elasticity of 1.8544 for the registration tax. This means that if Y_{NA} (non-agricultural GNP) increases by one percent, registration tax yield increases an average of roughly 1.8 percent. The coefficient of determination (R^2) at .919 is also very high. The estimate of the intercept is negative, as should be expected since tax yield is always less than Y_{NA}. Estimating equations for gift and inheritance tax and assets revaluation tax are shown below. Because of a recent change in the provision of basic deductions for the real estate speculation control tax, the prospect of tax yield from this source is very uncertain. Consequently, this tax revenue source is determined outside the model.

6. $\text{Log } T_{GH} = -28.7138 + \underset{(0.4253)}{2.7374} \log Y_{NA}$

$R^2 = .637 \quad D.W. = 2.22$

7. $T_{AR} = -262.7212 + \underset{(0.00017)}{0.00094} Y_{NA}$

$R^2 = .742 \quad D.W. = 1.03$

V. SUMMARY AND CONCLUSION

Accurate forecasts of the prospective growth of the tax revenue are needed to aid in the formulation of tax and expenditure policies. They are also essential for the analysis of the economic impact of the government budget. Advance information on tax revenues thus strengthens fiscal policy formulation. One method of making such forecasts is the income elasticity approach. In this paper an attempt was made to make quantitative assessment of the short-run revenue outlook of Korea's direct taxes through an income elasticity method. This approach generally assumes that the tax law and the quality of tax administration remain constant. However, our interest in this study lies more in the total relative increase in tax yields, whether due to economic growth, or changes in tax parameters, or improvements in administrative enforcement.

Table 5 summarizes the constant price forecasts of direct tax revenues for 1972 and 1973. With a considerable slowdown in the nation's economic activity combined with effects of new tax law, the total tax yield from direct taxes is expected to decline in 1965 constant price by about 8 percent. As shown in Appendix Table V, the growth of non-agricultural GNP is anticipated to decline sharply from 13 percent

in 1971 to 8.2 percent in 1972. Furthermore, an enactment of new tax law which became effective beginning 1972 is expected to result in a revenue loss of about 28 billion won in 1972.

Looking ahead to 1973, with a gradual recovery of the general economic activity, the growth of tax yields is anticipated to accelerate during 1973. Real yields from direct taxes are projected to increase by about 15 percent in 1973. Nominal increase, however, will be much bigger -- 22 percent. Table 6 presents the current price forecasts of direct tax revenue.

TABLE 5

PROJECTION OF DIRECT TAX REVENUE FOR 1972 AND 1973

(in billion wons of 1965 prices)

	1971 Actual	1971 Adjusted	1972 Estimates a/	1973 Estimates
Income Tax	70.7	70.2	63.0	72.0
Corporation Tax	37.3	31.8	28.6	34.0
Registration Tax	5.5	5.5	7.5	8.8
Gift and Inheritance	1.3	1.4	1.4	1.7
Assets Revaluation	0.9	0.9	1.0	1.1
Real Estate Speculation Control Tax	1.6	1.6	0.8 b/	-
TOTAL DIRECT TAX	117.3	111.4	102.3	117.6

Source: 1971 base year figures are from the Office of National Tax Administration, Seoul.

a/ 1971 actual figures have been adjusted for the amount of precollection this year of the tax liability to be incurred next year.

b/ Forecast figure from the Ministry of Finance.

TABLE 6

PROJECTION OF DIRECT TAX REVENUE FOR 1972 AND 1973

(in billion wons of current prices)

	1971 Actual	1971 Adjusted a/	1972 Estimates	1973 Estimates
Income Tax	107.6	106.7	104.7	127.1
Corporation Tax	56.7	48.3	47.5	60.1
Registration Tax	8.4	8.4	12.4	15.6
Gift and Inheritance	2.0	2.1	2.4	3.0
Assets Revaluation	1.3	1.3	1.6	1.9
Real Estate Speculation Control Tax	2.5	2.5	1.3 b/	-
TOTAL DIRECT TAX	178.5	169.3	169.9	207.7

Source: 1971 base year figures are from the Office of National Tax Administration, Seoul.

a/ 1971 actual figures have been adjusted for the amount of precollection this year of the tax liability to be incurred next year.

b/ Forecast figure from the Ministry of Finance.

APPENDIX TABLE I

NATIONAL TAX REVENUE IN KOREA
(in billion wons)

	1960	1962	1964	1965	1966	1967	1968	1969	1970	1971
INTERNAL TAX	19.8	21.4	28.9	41.8	70.5	104.0	156.9	208.5	286.9	364.[illegible]
1. Direct Tax	11.8	7.6	13.8	18.9	33.8	51.1	77.7	110.4	138.6	178.[illegible]
Personal Income	2.1	4.6	8.6	11.7	20.3	31.0	47.6	69.6	84.5	107.[illegible]
Corporation	0.9	2.0	4.1	5.7	10.9	15.9	24.6	33.1	42.4	56.[illegible]
Others a/	8.8	1.0	1.1	1.5	2.6	4.2	5.5	7.7	11.7	14.[illegible]
2. Indirect Tax	7.5	12.9	14.1	21.9	34.2	49.3	75.7	96.8	135.9	172.6
Business	1.0	1.9	3.2	4.4	7.3	11.6	17.5	23.0	31.0	37.9
Liquor	1.2	2.5	2.9	3.8	6.3	8.1	11.1	16.0	21.6	27.[illegible]
Commodity b/	4.3	4.7	3.3	7.0	10.3	15.4	22.2	24.8	36.9	45.[illegible]
Others c/	1.0	3.8	4.7	6.7	10.3	14.2	24.9	33.0	46.4	62.[illegible]
3. Others d/	0.5	0.9	1.1	1.0	2.4	3.6	3.5	1.3	12.4	13.[illegible]
CUSTOMS DUTIES	5.2	6.8	8.5	12.8	18.0	25.4	37.9	47.6	51.8	53.[illegible]
TOTAL TAX	25.0	28.2	37.4	54.6	88.5	129.4	194.8	256.1	338.7	417.[illegible]

Source: Government of Korea, Office of National Tax Administration, Statistical Yearbook of National Tax, (Seoul: November, 1971), pp. 26-7. And unpublished data for 1971.

a/ Included are receipts from inheritance and gift tax, registration tax, assets revaluation tax, real estate speculation tax, and land income tax and education tax for 1960.

b/ Includes textile tax.

c/ Includes petroleum products tax, transportation tax, electricity and gas tax. and admission tax.

d/ Includes stamp revenue.

APPENDIX TABLE II

NATIONAL TAX REVENUES IN KOREA: ANNUAL GROWTH RATES

	1960	1962	1964	1965	1966	1967	1968	1969	1970	1971
INTERNAL TAX	7%	19%	18%	44%	68%	48%	50%	32%	37%	27%
1. Direct Tax	2	-14	40	37	78	51	52	42	25	29
Personal Income	-3	86	45	35	74	52	54	46	21	27
Corporation	28	19	37	39	91	47	54	35	28	34
Others a/	1	-78	24	49	63	62	31	40	52	21
2. Indirect Tax	20	53	4	56	56	44	53	28	40	27
Business	-5	84	27	35	67	59	52	32	35	22
Liquor	13	73	6	28	68	28	38	43	35	25
Commodity b/	33	- 4	-13	113	47	49	45	11	49	22
Others c/	4	217	2	46	54	38	75	33	41	34
3. Others d/	-12	25	5	- 9	149	47	- 1	-64	875	6
CUSTOMS DUTIES	45	29	27	51	40	41	49	25	9	3
TOTAL TAX	13%	22%	20%	46%	62%	46%	50%	31%	32%	2[illegible]

Source: Government of Korea, Office of National Tax Administration, Statistical Yearbook of National Tax, (Seoul: November, 1971), pp. 26-7. And unpublished data for 1971.

a/ Included are receipts from inheritance and gift tax, registration tax, assets revaluation tax, real estate speculation tax, and land income tax and education tax for 1960.

b/ Includes textile tax.

c/ Includes petroleum products tax, transportation tax, electricity and gas tax, and admission tax.

d/ Includes stamp revenue.

APPENDIX TABLE III

COMPOSITION OF NATIONAL TAX REVENUE IN KOREA
(Percent of total)

	1960	1962	1964	1965	1966	1967	1968	1969	1970	1971
INTERNAL TAX	79.2%	75.9%	77.3%	76.5%	79.7%	80.4%	80.5%	81.4%	84.7%	87.3%
1. Direct Tax	47.2	27.0	36.9	34.6	38.2	39.5	39.9	43.1	40.9	42.8
Personal Income	8.4	16.3	23.0	21.4	22.9	24.0	24.4	27.2	24.9	25.8
Corporation	3.6	7.1	11.0	10.4	12.3	12.3	12.6	12.9	12.5	13.6
Others a/	35.2	3.5	2.9	2.8	2.9	3.2	2.8	3.0	3.5	3.4
2. Indirect Tax	30.0	45.7	37.5	40.1	38.6	38.1	38.9	37.8	40.1	41.4
Business	4.0	6.7	8.6	8.0	8.[illegible]	9.0	9.0	9.0	9.2	9.1
Liquor	4.8	8.9	7.8	6.9	7.1	6.3	5.7	6.2	6.4	6.6
Commodity b/	17.2	16.7	8.8	12.9	11.6	11.9	11.4	9.7	10.9	10.8
Others c/	4.0	13.5	12.3	12.3	11.6	11.0	12.8	12.9	13.7	14.9
3. Others d/	2.0	3.2	2.9	1.8	2.8	2.8	1.8	0.5	3.7	3.1
CUSTOMS DUTIES	20.8	24.1	22.7	23.5	20.3	19.6	19.5	18.6	15.3	12.7
TOTAL TAX	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Government of Korea, Office of National Tax Administration, Statistical Yearbook of National Tax, (Seoul: November, 1971), pp. 26-7. And unpublished data for 1971.

a/ Included are receipts from inheritance and gift tax, registration tax, assets revaluation tax, real estate speculation tax, and land income tax and education tax for 1960.

b/ Includes textile tax.

c/ Includes petroleum products tax, transportation tax, electricity and gas tax, and admission tax.

d/ Includes stamp revenue.

APPENDIX TABLE IV

METHOD FOR ADJUSTING ACTUAL TAX REVENUE DATA

In order to reach the revenue target set for a given year, the Office of National Tax Administration has been in practice since 1969 of collecting in advance certain amount of tax liability legally due in the following year. For our purpose of analyzing functional relationship between tax yields and changes in aggregate income, actual tax revenue data for 1969-1971 have been adjusted to eliminate the effect of this distortion. The method of adjustment is illustrated below.

	1969	1970	1971
T	207.2	274.5	351.1
T^p	8.7	17.4	32.1
$(T_t - T^p_t)$	198.5	257.1	319.0
$\overset{*}{T}_t = (T_t - T^p_t) + T^p_{t-1}$	198.5	265.8	336.4

T = Actual tax revenue

T^p_t = Amount of tax collected in advance in year t

T^p_{t-1} = Amount of tax collected in advance in previous year

$\overset{*}{T}$ = Adjusted tax revenue in year t

APPENDIX TABLE V

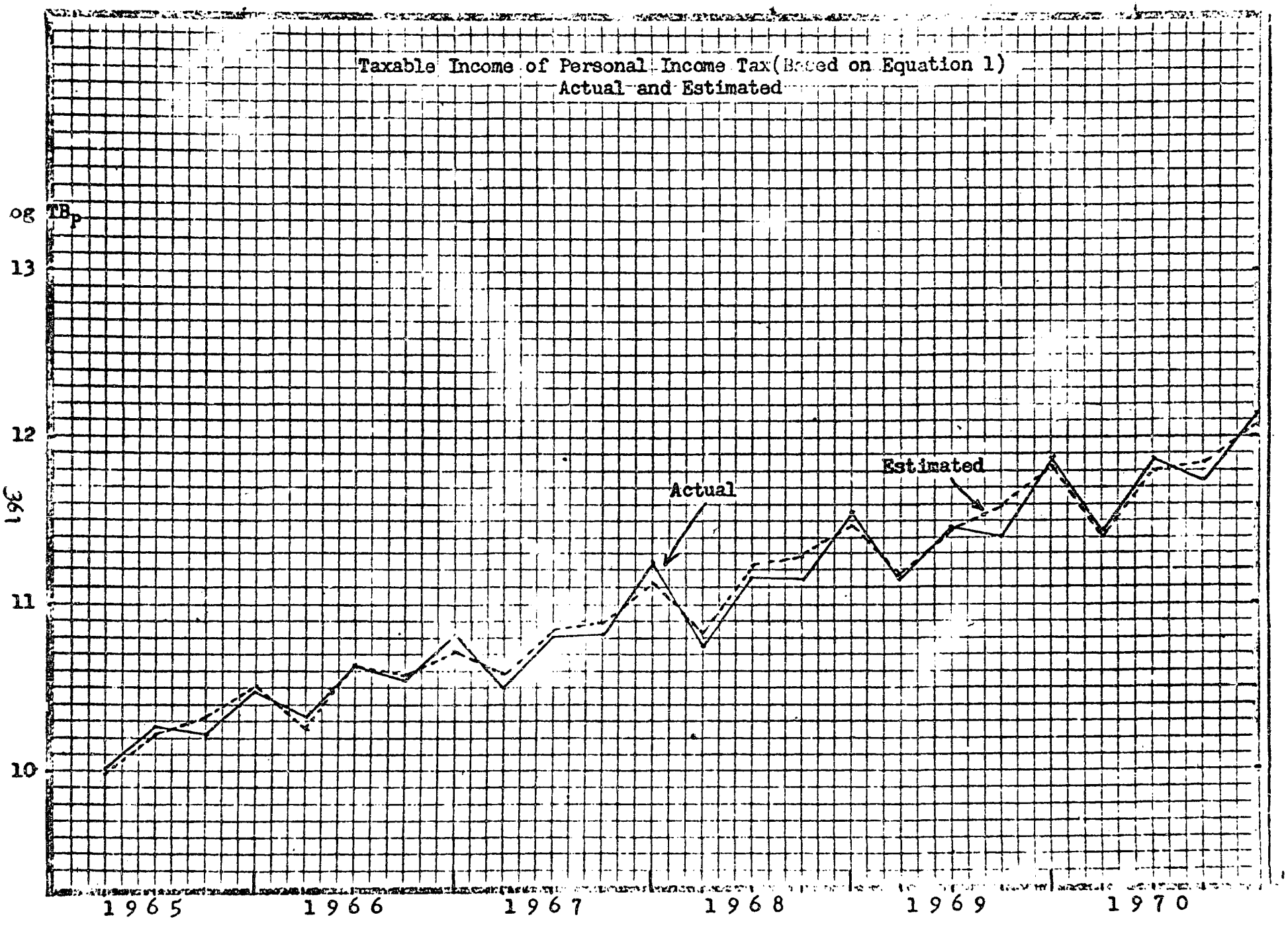
MAJOR ECONOMIC ASSUMPTIONS

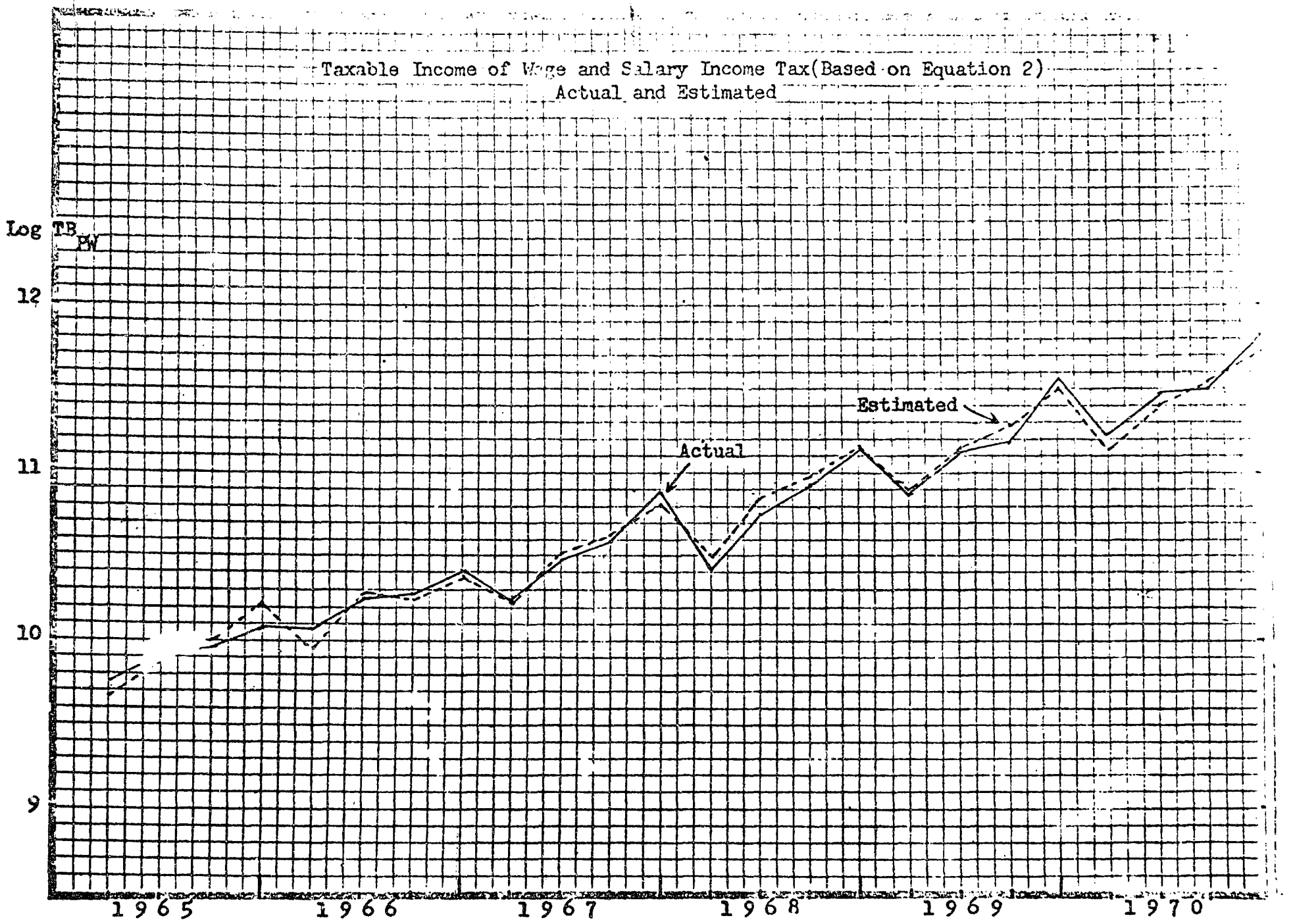
	1971	1972	1973
GNP[a/]	1,566.9	1,681.7	1,827.6
Non-agricultural GNP[a/]	1,190.5	1,288.3	1,418.4
Non-agricultural Employment[b/]	5.0	5.2	5.3
ANNUAL GROWTH RATE:			
GNP	10.2%	7.3%	8.7%
Non-agricultural GNP	12.8	8.2	10.1
Non-agricultural Employment	5.5	3.0	3.0
Wholesale Price Index	8.7	13.3	7.4

Source: Korea Development Institute, Growth Strategy for Overall Resources Budget Plan, Seoul, 1972.

a/ In billions of 1965 prices.

b/ In millions.


Taxable Income of Personal Income Tax (Based on Equation 1)
Actual and Estimated
og TB_p
13
12
11
10
Actual
Estimated
1965
1966
1967
1968
1969
1970


Taxable Income of Wage and Salary Income Tax(Based on Equation 2)
Actual and Estimated
Log TB_{PW}
12
11
10
9
Actual
Estimated
1965
1966
1967
1968
1969
1970

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PLANNING MODEL COMBINING INTERINDUSTRY AND AGGREGATE MODELS

Byung-Nak Song

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PREFACE

This paper is one in the series of continuing KDI research works which is designed to aid in the formulation of sound public policies and to promote public understanding of issues of the Korean economy.

This paper is part of a large project on "Planning Models for the Korean Five-Year Plans and Overall Resource Budgets," in which the author intends to develop a combined planning model (CPM) by integrating the macro and the input-output models into a single consistent equation system. The planning model suggested in this paper is designed for the Korean Five-Year Economic Plans, and is intended to be used and revised every year as a part of the annual Overall Resource Budgets formulating process.

The interpretations and conclusions in this paper are those of the author and do not represent the views of the Korea Development Institute. Finally, I would like to extend my appreciation to those within and outside of this Institute who have participated in these endeavours.

Mahn Je Kim
President

PLANNING MODEL COMBINING INTERINDUSTRY AND AGGREGATE MODELS

by

Byung-Nak Song*

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* I wish to express my sincere gratitude to Professor Irma Adelman for comments and careful review of the model, and to Professor Dale W. Jorgenson for valuable suggestions. I am grateful for discussions with Sherman Robinson, Roger Sedjo, Larry Westphal and the Senior Fellows at KDI, and for computer support from Dai Young Kim.

Distribution of this preliminary version of the model is for the purpose of securing critical comment.

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I. INTRODUCTION

This paper attempts to develop a combined planning model (CPM) by integrating the aggregate and the input-output models into a single consistent equation system. The potential use of CPM in the planning of economic development has been suggested by a number of economists[1]. Empirical work with CPM for national development planning is still at an experimental stage, and has now progressed to the stage where some rather interesting implications are being drawn from some of these models. The power of the CPM technique is that it provides simultaneously both aggregate and disaggregate estimates in a consistent framework, and also makes it possible to obtain information contained in both approaches. Either the input-output or the aggregate model, by itself, is inadequate as a planning model. The former, focussing mainly on the analysis of supply details, ignores completely final demand analysis, as the level of final demand in the input-output model is simply assumed to be exogenously determined outside the model. Conversely, the latter model, dealing largely with an analysis of final demand at aggregate level, ignores the detailed analysis of the supply side and of intermediate demand. Thus, what is needed in planning an economy is a more general system, encompassing both the input-output model and the traditional aggregative econometric model.

---

[1] See Chenery, Mahn Je Kim and Westphal [7], Fisher and Klein [9], Jorgenson [12], Klein [16], Sedjo [19], Westphal and Adelman [21], and Econometric Models for Japan [10].

By combining the two models one can determine the level of final demand from equations of economic behavior in the aggregate model, and estimate the level of sectoral outputs, employment, imports, and investment requirements corresponding to that level of final demand by means of input-output relationships.

The methodological difficulties and data requirements one faces in trying to develop and test this type of model are enormous. Nevertheless, rapid recent advances in computational techniques and in the methodology of economic model-building have made it possible to develop and experiment with such models. Also, an increasing demand by policy makers for more detailed policy prescriptions for the highly complicated economic system necessitates the development of such a model.

The model suggested in this paper is designed for the Korean Five-Year Economic Plans, and is intended to be used and revised every year as a part of the annual Overall Resource Budgets formulating process. For the successive Korean FYP's both the aggregate and the input-output models have been developed and used. The former models are mainly of the Adelman-Kim type[2] and the latter models are mostly of the Adelman-Cole-Norton-Lee type[3]. These two types of models indicate the way in which the planning models could be formulated in the Korean context

---

[2] See Adelman and Kim [2], Kim and Norton [14, 15], Kim and Nam [13].

[3] See Adelman [1]. For a partial list of the interindustry models see Almon [3], Bruno [5], Jorgenson [11], Leontief [17], Nugent [18], Westphal [20], Wolkow [22].

and show various sources of data available for planning purposes. Thus, they may form the basis for formulating the model suggested in this paper.

II. ECONOMIC PLANS AND PLANNING MODELS IN KOREA

The first economic planning work in Korea was begun in 1954 by Robert R. Nathan and Associates, who prepared an economic program for the U.N. Korean Reconstruction Agency for the purpose of assessing the best patterns and the potential costs of rehabilitating the Korean economy. The second planning work was a seven-year plan prepared by the Economic Development Council of the Rhee government in 1958. The plan consisted of a three-year phase, 1960-62, and a four-year phase, 1963-66. Only the plan for the first phase was formulated and started in 1960, but with the overthrow of the Rhee government it was discarded. In 1961 a five-year plan was prepared by the new government but it suffered the same fate as the three-year plan due to the military coup of May, 1961. The First Five-Year Plan, 1962-66, was the third planning attempt, which was the first plan in Korea finally carried through to completion. The Second Five-Year Plan, 1967-71, was prepared in 1966 and was intended to be subsequently supplemented and modified by annual plans, called Overall Resource Budgets (ORB's), prepared each year since 1967. The Third Five-Year Plan, 1972-76, is the latest FYP.

Up to the FFYP formal planning models had not been used. It was only since the FFYP that planning models have been systematically applied to Korean economic planning. Models used for the Five-Year

Economic Plans are, as previously mentioned, represented by the Adelman-Kim type of macro-models and Adelman's sectoral model. Models developed for annual OEB's are the Kim-Norton OEB model[4], the Kim-Norton stabilization model[5], the Kim-Nam financial planning model[6], etc. The Adelman-Kim model was used for the SFYP, but it was primarily designed for the OEB's.

As the Adelman-Kim model is representative of the macro-models used for Korean economic planning, it will be briefly presented at this juncture. The model combines the Gurley-Shaw theory of finance with the famous Chenery 'two gap' approach, and tries to examine the effects of alternative monetary and financial policies consistent with alternative growth paths. The model consists of five groups of structural equations; that is, production, consumption, investment, import and some tax and monetary equations. Production and investment were equally divided into four sub-sectoral functions; that is, primary, mining and manufacturing, social overhead and service sectors. Imports are disaggregated into machinery, raw materials and all other imports. Consumption is divided into three sub-groups; food, nonfood, and government consumption. The complete model has twenty-six endogenous variables, five policy variables, and thirteen other predetermined and exogenous variables. The system consists of fourteen statistical equations and twelve identities.

---

4 See Kim-Norton [15].

5 See Kim-Norton [14].

6 See Kim-Nam [13].

In the model discussed in this paper consumption, investment, imports and exports are all disaggregated into sixteen sectors. This sixteen sector classification is an extension and refinement of the fourteen sector classification used for the TFYP. Detailed descriptions and comparisons of the different sector classifications are shown in Appendix Table G.

The model discussed in this paper is intended to be used for indicative planning. The SFYP, based on the sectoral model, was a centralized, comprehensive resource planning type. The TFYP, based on the macro model, was a policy planning type. The model suggested in this paper attempts to combine both the resource planning strategy and the comprehensive policy planning techniques by incorporating the macro and sectoral models.

III. DEVELOPMENT OF THE MODEL

A joint model may be developed by extending either the inter-industry model or the aggregate model. As the former model has been used for planning purposes mainly as the consistency or the programming type of model, extensions of the input-output model are also of two types, that is, extensions of either the consistency type of model or of the programming type of model.

Version I - extension of the macroeconometric model

Version II - extension of the consistency type of model

Version III - extension of the programming type of model

Version one formulates the aggregate model in the interindustry framework by disaggregating the components of the macro model into

input-output sectors, and estimates the values of aggregate variables at the disaggregated input-output sector level. The Adelman-Kim model used for the Korean Second Five-Year Economic Plan is an example of this approach. Adelman and Kim divided the Korean economy, on the production side, into four sectors (primary, mining and manufacturing, social overhead, and services). On the demand side, they split the expenditure components of GNP into several categories--three types of consumption expenditures, four types of investment equations, and three types of import equations.

Version two consists in adding behavioral equations to the interindustry model, and estimates the level of the components of final demand with behavioral equations instead of assuming that they are determined exogenously outside the model. An example of the consistency model is the sectoral model used for the Korean Second Five-Year Plan. The model was designed and used primarily to provide an efficient set of investment projects consistent with alternative growth paths implied by the model. The set of growth paths was constrained by a set of investment constraints--an efficient set of investment projects. The use of these constraints in the Korean sectoral model differentiates it from ordinary interindustry models. However, the Korean sectoral model is still in the tradition of the standard interindustry model and does not contain behavioral equations in the system. The extension of this type of model consists in adding equations of economic behavior to the input-output model to determine the level of consumption, investment, and export and import demand for goods and services of various sectors.

Version three combines the behavioral analysis with the interindustry programming model. In this version, feasible solutions to the optimization model are subject to the behavioral constraints. The Bruno model for Israel[7] may be an example of this approach. In his model, he maximizes the discounted sum of private consumption over the planning period, plus the terminal capital stock. Feasible solutions to his model are subject to savings, trade, exchange, and labor constraints.

Among these three alternative versions, the second one appears to be the most appropriate model to experiment with in the Korean context and may be the most promising planning model for developing countries. Formulating the macro model in the interindustry framework is, of course, an enormous improvement of and an advance over the traditional aggregate model. However, in many cases, due to data limitations it cannot be formulated in a form as disaggregated as the input-output sectors. Also, like other macro models it still leaves out the analysis of intermediate demand. As indicated in Chenery and Watanabe's cross country comparison of production structure, 40-50 percent of total domestic demand for goods and services comes from other industries instead of from final purchasers[8]. For countries like Korea, facing the problem of small market size, interindustry demand plays a large

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[7] See Bruno, M. et al. [5], and Bruno, M. "Optimal Patterns of Trade and Development," The Review of Economics and Statistics, 49, No. 4, 545-554.

[8] See Chenery, H. B. and T. Watanabe. "International Comparisons of the Structure of Production," Econometrica, XXVI (October, 1958), 487-521.

role in providing a market for other industries. When a country is very primitive and is dominated by subsistence agriculture sector the usefulness of input-output model and the role of intermediate demand may be insignificant. In the case of Korea, interindustry demand was about 42 percent of aggregate demand in 1966, and in 1968 went up to 46 percent. As the role of intermediate demand in Korea is very significant, any planning model which ignores interindustry demand may not be, for this reason, suitable for the Korean economic planning. This high level of interindustry activity justifies and necessitates the use of the interindustry model in Korean economic planning, and the availability of the input-output tables, prepared in 1960, 1963, 1966, 1968, makes it possible to experiment with the sectoral models.

Although version three seems to be the most promising model for future planning it has not been designed and used for Korean economic planning, and does not exist in a form useful in the Korean context. Thus, what seems to be the most appropriate step toward the formulation of the combined planning model in the Korean context is to extend the consistency type of interindustry model used for the Third Five-Year Plan by adding behavioral equations of the form suggested in the Adelman-Kim model. In the Adelman-Kim model, consumption expenditures are related to after-tax GNP and relative prices. Investment equations are of the accelerator type and include some financial variables. Imports are made a function of value added and the relative prices of foreign and domestic goods.

IV. INTEGRATION OF THE MACRO AND INPUT-OUTPUT MODELS

1. Basic Model

GNP can be estimated from both the macro model and the input-output model. It can be shown, from the macro model, as

(1) $$V = C + G + E + I - M$$

and from the input-output model as

(2) $$\sum X_i - \sum_i \sum_j a_{ij} X_j = \sum C_i + \sum G_i + \sum E_i + \sum Z_i - \sum M_i$$

where X_i = outputs of sector i

C_i = private consumption demand for sector i

G_i = government consumption demand for sector i

E_i = export demand for sector i

Z_i = investment demand for sector i

M_i = import demand for sector i

a_{ij} = input coefficients

I = aggregate investment

V = GNP

C, G, E, M are aggregates.

From equations (1) and (2) we find

(3) $$V = \sum X_i \quad \sum_i \sum_j a_{ij} X_j.$$

Estimation and substitution of consumption equations of the following form leads to the famous Chenery 'two gap' model:

(4) $S - I = E - M$

where S is total savings, and C and G are estimated as:

(4.1) $C = \underset{(0.01)}{0.79}\ V$ $\qquad R^2 = 0.99 \qquad (1960\text{-}1970)$

(4.2) $G = \underset{(0.003)}{0.09}\ V$ $\qquad R^2 = 0.99 \qquad (1960\text{-}1970).$

Thus:

(4.3) $S = 0.12\ V.$

And from equations (2) and (3) we have

(5) $$.12\ (\sum X_i - \sum_i \sum_j a_{ij} X_j) = \sum E_i + \sum Z_i - \sum M_i.$$

The two gaps at the sectoral level can be shown as:

(6) $$\theta_i\ (X_i - \sum_j a_{ij} X_j) = E_i - M_i + Z_i$$

where $(1 - \theta_i)$ is the proportion of sector i'th net output which is consumed by firms, households, and government. Imports and exports are in the following forms. Price variables are, for the sake of simplicity, excluded from the equations. But it does not affect the generality of the model. They will be included in the model in a later stage.

(6.1) $E_i = \alpha_i X_i$

(6.2) $M_i = \beta_i X_i + \delta_i.$

Relationships between savings at the aggregate and disaggregate levels are, from equations (5) and (6), shown as:

$$(6.3) \qquad .12\ (\Sigma X_i - \sum_i \sum_j a_{ij} X_j) = \Sigma \theta_i\ (X_i - \sum_j a_{ij} X_j).$$

Investment equations are, as shown in Table 3, of the following form

$$(7) \qquad I_{it} = \gamma_i\ (X_{it} - X_{it-1}) + f_i(R_t)$$

where R is a proxy for a set of financial variables such as money supply, time deposits and government non-consumption expenditures.

Arranging terms in equation (6), we have*

$$(8) \qquad X_{it}\ (\theta_i - \alpha_i + \beta_i) - \theta_i \sum_j a_{ij} X_{jt} = Z_{it}$$

$$(9) \qquad X_{it-1}\ (\theta_i - \alpha_i + \beta_i) - \theta_i \sum_j a_{ij} X_{jt-1} = Z_{it-1}.$$

From equations (8) and (9) the following equation results

$$(10) \qquad X_{it} - X_{it-1} = \theta_i B_i \Sigma a_{ij}\ (X_{jt} - X_{jt-1}) + B_i\ (Z_{it} - Z_{it-1})$$

where $B_i = (\theta_i - \alpha_i + \beta_i)^{-1}$.

From equations (7) and (10) we find

$$(11) \qquad I_{it} = \gamma_i\ \theta_i B_i \sum_j a_{ij}\ (X_{jt} - X_{jt-1}) + \gamma_i B_i (Z_{it} - Z_{it-1}) + f_i(R_t).$$

Alternatively we have

$$(12) \qquad Z_{it} = Z_{it-1} + [I_{it} - \gamma_i\ \theta_i B_i \Sigma a_{ij}\ (X_{jt} - X_{jt-1}) - f_i(R_t)] / \gamma_i B_i.$$

* δ in (6.2) can easily be added to (8) and (9).

Relationships between I_{it} and Z_{it} can be shown as:

$$(13) \qquad b^*_{ij} I_{jt} = Z_{it}$$

where b^*_{ij} = capital coefficients in share form.

From equations (8)-(12) we find the level of sectoral output in matrix form as:

$$(14) \qquad X_{it} = X_{it-1} + (1 - [\bar{a}_{ij}])^{-1} B_i (Z_{it} - Z_{it-1})$$

where $[\bar{a}_{ij}] = \theta_i B_i [a_{ij}]$.

$$(15) \qquad X_t = X_{t-1} + (I - \bar{A})^{-1} B(Z_t - Z_{t-1}).$$

Substituting aggregate values of equation (11) into (14) we have

$$(16) \qquad \Sigma X_{it} = \Sigma X_{it-1} + \sum_i \sum_j A_{ij} f^*_i(R) - \sum_i \sum_j A_{ij} Z^*_{it-1}$$

where $[A_{ij}]$ = inverse of $[a^*_{ij}]$

$$[a^*_{ij}] = [w_i \theta_i B_i a_{ij}]$$

$$w_i B_i = 1/(\theta_i - \alpha_i + \beta_i - \gamma_i)$$

$$f^*_i(R) = w_i B_i f_i(R)$$

$$Z^*_{it-1} = w_i B_i Z_{it-1}.$$

2. Model with Price Variables

Inserting appropriate price variables into the consumption, import and export equations we have

(17) $C_i = a_{1i}C + a_{2i}(P_i^c/P^c) + a_{oi}$

(18) $M_i = \beta_{1i}X_i + \beta_{2i}P_i^m + \beta_{oi}$

(19) $E_i = \alpha_{1i}X_i + \alpha_{2i}P_i^e + \alpha_{oi}$

where P_i^c = consumer price of sector i

P^c = consumer price index

P_i^m = import price-exchange rate variable for sector i

P_i^e = export price-exchange rate variable for sector i.

Substituting these equations into (2) in disaggregated form and arranging terms we have, in matrix form,

(20) $X_t = X_{t-1} + (I - A + H)^{-1} \cdot R$

where $R = DQ_t + DS_t + DZ_t$

Q and S are vectors of

$Q_i = a_{2i}(P_i^c/P^c) + \beta_{2i}P^m + \alpha_{2i}P_i^e$

$S_i = a_{1i}C + G_i + a_{oi} + \beta_{oi} + \alpha_{oi}$

H = diagonal matrix of $(\beta_{1i} - \alpha_{1i})$

D = difference operator.

As $(E_i - M_i + Z_i) / \theta_i - (C_i + G_i) = E_i + Z_i - M_i$, equations (15) and (20) can be transformed into each other.

V. SOME NUMERICAL RESULTS

The preliminary results of some numerical computations based on the above model are reported in Appendix A-G. They are to be considered only as illustrative of the general implications of the model. Some of the coefficients of major variables still require revision.

Appendix G summarizes the estimates of sectoral outputs in 1968. The difference between estimated and actual output at the aggregate lev is less than 4%, while at the sectoral level it varies among sectors. large proportion of the errors were found to have resulted from the mi classification of some industries.

VI. ALTERNATIVE SPECIFICATIONS OF THE MODEL

1. Equations*

Supply-demand balance

(1) $$X_i + M_i = \sum_j a_{ij} X_j + C_i + Z_i + E_i$$

Consumer demand and savings

Version I

(C1) $$\log C_i = \eta_i^c \log C + \eta_{io}$$

* These equations require revision, and may not constitute a single consistent equation system.

(C2) $$C_{it} = C_{i68}\left[1 + \eta_i^c\left(\frac{C_t - C_{68}}{C_{68}}\right)\right]$$

(C3) $$C_{it}^b = C_{i68}^b\left[1 + \eta_i^b\left(\frac{C_{it} - C_{i68}}{C_{i68}}\right)\right]$$

(C4) $$C_{it}^m = C_{i68}^m\left[1 + \eta_i^m\left(\frac{C_{it} - C_{i68}}{C_{i68}}\right)\right]$$

(C5) $$C_i = C_i^b + C_i^h$$

(C6) $$C_i = C_i^m + C_i^d$$

(C7) $$C = \Sigma C_i$$

(C8) $$C = \eta_1 V + \eta_o$$

<u>Version II</u>

(C9) $$C_i = \eta_{2i} C + \eta_{3i}(P_i^c/P^c) + \eta_{4i}$$

(C10) $$C = \eta_5(V - T) + \eta_6(P^c/P^w) + \eta_7$$

(C11) $$C = \eta_8(V - T) + \eta_9(P^c/P^w) + \eta_{10}(MS \text{ or } R) + \eta_{11}$$

(C12) $$C^{mg} = \eta_{12} C^f + \eta_{13} V^{ag} + \eta_{14} POP + \eta_{15}$$

(C13) $$C^{mng} = \eta_{16}(V - V^{ag}) + \eta_{17}$$

(C14) $$C = \eta_{18}(V/POP) + \eta_{19}(P^c/P^w) + \eta_{20} D(V/POP)_t + \eta_{21} t$$

(C15) $$C^m = C^{mg} + C^{mng}$$

Government consumption

(G1) $\log G_i^c = \beta_{1i} \log G + \beta_o$

(G2) $G_{it}^c = G_{io}^c \left[1 + \beta_{1i} \left(\frac{G_t - G_o}{G_o} \right) \right]$

(G3) $G^{d\circledast} = \sum G_i^{d\circledast}$

(G4) $G^m = G_o^m \left[1 + \beta_{2i} \left(\frac{G_t - G_o}{G_o} \right) \right]$

(G5) $G_i^c = G_i^d + G_i^m$

(G6) $G = \beta_3 V + \beta_4$

(G7) $G = \beta_5 T + \beta_6$

(G8) $G^c = \sum G_i^c$

(G9) $G = G^c + G^v$

Investments

(I1) $I_1 = \gamma_{1.1} DX_{1t} + \gamma_{2.1} GNC + \gamma_{0.1}$

$I_r = \gamma_{1r} DX_{rt}$ $(r = 2, \ldots, 11, 13)$

$I_{12} = \gamma_{1.12} DX_{12t} + \gamma_{3.12} (MS + TD) + \gamma_{0.12}$

$I_{14} = \gamma_{1.14} DX_{14t} + \gamma_{0.14}$

$I_{15} = \gamma_{1.15} DX_{15t} + \gamma_{2.15} GNC + \gamma_{0.15}$

$$I_{16} = \gamma_{1.16} DX_{16t} + \gamma_{3.16} (MS + TD) + \gamma_{0.16}$$

$$\sum I_i = \gamma_{1.17} D \sum_i X_{it} + \gamma_{0.17} \qquad (i = 2, 4, \ldots, 11)$$

$$\sum I_i = \gamma_{1.18} D \sum_i X_{it} \qquad (i = 2, \ldots, 11)$$

(I2) $$Z_{it} = \sum_j b_{ij} DX_{jt}$$

(I3) $$I^1 = \sum_i I_i^1 = \sum_i Z_i^1$$

(I4) $$Z_i^2 = \sum_j h_{ij} DX_{jt}$$

(I5) $$I = \sum_i I_i^1 + \sum_i Z_i^2$$

(I6) $$b_{ij}^* I_j = Z_i$$

(I7) $$Z_i^m = \sum_j b_{ij}^m DX_{jt} + \sum_j H_{ij}^m DX_{jt}$$

(I8) $$Z_i^d = \sum_j b_{ij}^d DX_{jt} + \sum_j H_{ij}^d DX_{jt}$$

(I9) $$Z_i = Z_i^m + Z_i^d$$

Exports

(E1) $$E_i = \alpha_{1i} X_i$$

(E2) $$E_i = \alpha_{2i} X_i + \alpha_{3i} P^e + \alpha_{4i}$$

(E3) $$E = \sum E_i$$

(E4) $E^m = \theta_1' (1 - A)^{-1} E$

Imports

(M1) $M_i = \theta_{1i} X_i + \theta_{ci}$

(M2) $M_i^c = \theta_{2i} X_i + \theta_{3i} P_i^m + \theta_{4i}$

(M3) $M_i^{nc} = \theta_{5i} X_j + \theta_{6i} P_i^m + \theta_{7i}$

(M4) $M_i = M_i^c + M_i^{nc}$

(M5) $M = \sum M_i$

(M6) $M_i = C_i^m + G_i^m + Z_i^m + \sum_j a_{ij}^m X_j + E_i^m$

Intermediate demand

(W1) $W_i = \sum_j a_{ij} X_j$

(W2) $W_i^m = \sum_j a_{ij}^m X_j$

(W3) $W_i^d = \sum_j a_{ij}^d X_j$

(W4) $W = \sum_i W_i$

Employment

(N1) $N_h = \sum_j N_{hj} X_j \qquad (h = 1, \ldots, 7)$

(N2) $N_f = \sum_j N_{fj} X_j \qquad (f = 1, \ldots, 6)$

(N3) $\sum_h \sum_j N_{hj} X_j \leq L$

(N4) $\sum_f \sum_j N_{fj} X_j \leq L$

(N5) $\log N_h = a + bt$

(N6) $\log N_h = a + b \log t$

Wages

(WA1) $\frac{\Delta W}{W} = a_1 (\frac{\Delta P}{P}) + a_2 \ (UR)$

Financial Sector

Money supply

(F1) $MS = \lambda_1 \ BC^{pu} + \lambda_2 \ BC^{pr} + \lambda_3 \ BC^{f} + \lambda_4 \ RLD$

(F2) $DMS = \lambda_5 \ BC^{pu} + \lambda_6 \ BC^{pr} + \lambda_7 \ BC^{f} + \lambda_8 \ t$

Demand deposits

(F3) $MD = \lambda_9 \ BC^{pu} + \lambda_{10} \ BC^{pr} + \lambda_{11} \ BC^{f}$

(F4) $DMD = \lambda_{12} \ BC^{pu} + \lambda_{13} \ BC^{pr} + \lambda_{14} \ BC^{f} + \lambda_{15} \ RLD$

Currency

(F5) $MC = \lambda_{16} \ GNP1 + \lambda_{17}$

Turnover of demand deposits

(F6) $\log TN = \lambda_{18} \log t$

Loan

(F7) $\log EL = \lambda_{19} \log t + \lambda_{20}$

Balance-of-payments constraint

(2) $E + F + S^{e} \geq M$

Savings-investment constraint

(3) $S_t + sDV_t + F_t - S_t^{e} \geq I_t$

GNP definition

(4) $V = C + G + I + E - M + V^{f}$ (national income account)

(5) $X = W + C + G + Z + E - M + V^{f}$ (input-output account)

2. Notation

Industry subscripts (for 16-sector classification see appendix)

$i, j = 1, \ldots, 16$

2, ..., 11 (mining and manufacturing sector)

13, 15 (SOC sector)

12, 14, 16 (service sector)

Time subscripts

$t = 1, \ldots, 11 = 1960, \ldots, 1970$

Variable subscripts

$h = 1, \ldots, 7$ (labor skill categories)

$u = 1, \ldots, 7$ (classes of workers)

Variable superscripts

b	= business	c	= consumption
co	= competitive	d	= domestic
de	= defence	e	= exports
f	= foods	g	= government
h	= households	m	= imports
mg	= grain imports	mna	= imports of nonagricultural goods

X_i = output of sector i

Z_i = investment demand for sector i

C, G, E, I, M, W, X, Z are in aggregates

C^m, G^m, E^m, Z^m (m denotes 'imported')

C^d, G^d, E^d, Z^d (d denotes 'domestic')

Exogenous Variables

BC^f = bank credit to foreign sector

BC^{pr} = bank credit to private sector

BC^{pu} = bank credit to public sector

F = net foreign-capital commitments available for the period

G^c = government consumption demand

G^{de} = government defense expenditure

G^v = value added in the government sector

GNC = government nonconsumption expenditures

K = capital stock

L = supply of labor

N = employment

P = price index (1965 = 100)

P^c = consumer price index

P^w = wholesale price index

P^e = exports price-exchange rate variable

P^m = imports price-exchange rate variable

POP = population

R = rate of interest

RLD = ratio of loans to deposits at commercial banks

nc = non-competitive

v = value added

Z^1 = capital investment

Z^2 = inventory

Endogenous Variables

C_i = private consumption demand for sector i

C_i^b = business consumption demand for sector i

C_i^h = households consumption demand for sector i

E_i = exports of sector i'th goods

EL = total loans/equipment loans

G_i = government consumption demand for sector i

I_i = investment in sector i

M_i = imports of sector i'th goods

M^{co} = competitive imports

M^{nc} = non-competitive imports

MC = currency

MD = demand deposits

MS = money supply

S = saving

TN = turn-over of demand deposits

V = GNP

w = wage

W_i = intermediate demand for sector i

S_t^e = foreign exchange surplus carried over from the previous period

T = tax

TD = time deposits outstanding

UR = unemployment rate

Parameters

a_{ij} = input coefficients

b_{ij} = capital-output coefficients

b_{ij}^* = b_{ij} in share form

h_{ij} = inventory coefficients ($h_{ij} = 0$ if $i \neq j$)

N_{hj} = employment of skill type h in industry j

N_{uj} = employment of working class u in industry j

s = marginal propensity to save

η_i = private consumption expenditure elasticity

β_i = government consumption expenditure elasticity

γ_{1i} = acceleration coefficients

α_i = exports coefficients

θ_i = imports coefficients

λ_i = credit coefficients

Other

D = difference operator

L = log operator

VII. EXPLANATORY NOTES

In this model the level of final demand is determined by the behavioral equations such as C11, G7, I1, E2, M2, etc., and intermediate demand by intermediate input coefficients (W1). Gross outputs corresponding to the level of these final and intermediate demands are then determined by the input-output system. Consistency is assured by equation (1). The main elements in the model are:

The productive system

This is characterized by fixed-inputs technology. Material inputs requirements are determined by the input-output coefficients a_{ij}'s. They are derived from the 1968 input-output table for the Korean economy and will be adjusted for predictable technological changes foreseen in the near future. Demand for labor is determined by fixed labor input

coefficients (N1, N2). The level of investment for sector i is estimated by the behavioral equation (I1). Investment demand for capital goods can be estimated by fixed capital-output coefficients. The share of capital goods in sectoral investment is determined by conversion coefficients in (I6).

Final demand

1). Private consumption

Business consumption C^b and households consumption C^h are combined (C5) and estimated jointly (C9, C11, C2). Sectoral consumption expenditures were related to after-tax income and relative prices (C9). Alternatively, expenditure elasticities were calculated for each sector in order to project consumption expenditures by sector and by type (C1, C3, C4).

2). Government consumption

Aggregate government consumption is related to tax revenue intake (G7). Sectoral allocation is determined by expenditure elasticities (G1, G2). Government defense expenditure is exogenous (G3).

3). Investment

Inventory investment is related to the level of output (I4). Capital investment equations are of the 'accelerator' type and include some financial variables. Capital investment is disaggregated into sixteen sectors (I1). Number of variables included in investment

equations vary over sectors. Investment equations in mining and manufacturing sectors take the same form.

4). Exports

Exports by sector are related to outputs and export-prices. Runs will be performed with and without price variables (E1, E2).

5). Imports

Imports are related to sectoral outputs and import price-exchange rate variables (M2). Competitive imports are regressed on sectoral outputs and import price-exchange rate variables (M2) and noncompetitive imports are related to outputs of the using sector and the relative price variables (M3). Imports for the components of final demand and intermediate demand are determined by equations C4, G4, I7, E4, and W2.

6). Employment and Wages

Employment levels by skill and work classes are determined by fixed labor input coefficients (N3, N4). Wages are related to changes in prices and unemployment rate (WA1).

7). Financial sector

Money supply and demand deposits are related to bank credits and loans (F1, F4). Currency is related to GNP (F5).

8). Balance-of-payments

For each time period total imports cannot be greater than the sum

of exports, foreign capital commitments, and the accumulated balance-of-payments surplus (Eq. 2).

9). Savings-investments

Total investment is constrained by the funds available for this purpose from domestic and foreign sources (Eq. 3).

10). Consistency between:

A. Supply (domestic production plus imports) and demand (intermediate and final demand) (Eq. 1).

B. Aggregates and disaggregates (C7, G8, I5, E3, M5, W4).

A. National Income Aggregates in the First, Second and Third Five-Year Plans; Planned vs. Actual

		First Five-Year Plan, 62-66				
		1962	1963	1964	1965	1966
1. Gross National Product	P*	612.75	651.97	699.56	752.69	816.72
	A*	634.97	693.03	750.31	805.85	913.82
Rate of Growth	P	5.7	6.4	7.3	7.8	8.3
	A	3.5	9.1	8.3	7.4	13.4
2. Private Consumption Expenditure	P	507.64	526.02	552.64	591.63	643.14
	A	568.96	587.74	620.44	669.08	716.99
GNP Share	P	78.3	76.3	74.7	74.1	74.4
	A	89.6	84.8	82.7	83.0	78.5
3. Government Consumption Expenditure	P	70.74	71.60	72.82	74.02	76.10
	A	69.84	73.84	71.18	76.02	84.76
GNP Share	P	13.8	13.1	12.4	11.7	11.1
	A	11.1	10.6	9.5	9.4	9.3
4. Gross Investment	P	100.28	121.24	137.51	145.92	153.17
	A	77.99	137.27	114.41	118.48	207.38
GNP Share	P	16.7	19.0	20.1	19.8	19.3
	A	12.2	19.8	15.2	14.7	22.7
5. Exports	P	48.03	55.37	63.31	73.91	82.48
	A	36.71	39.44	48.75	68.61	104.49
GNP Share	P	6.6	7.1	7.6	8.2	8.4
	A	[illegible]	5.7	6.5	8.5	11.4
6. Imports	P	127.99	136.92	140.06	141.68	145.95
	A	120.20	153.19	114.04	128.93	203.30
GNP Share	P	15.4	15.5	14.8	13.8	13.2
	A	18.9	22.1	15.2	16.0	22.2
7. Net Factor Income from the Rest of the World	A	6.5	6.8	6.5	7.6	13.1

* P: Planned A: Actual
Unit: In 1965 billion won

(continued)

A. National Income Aggregates, page 2

		Second Five-Year Plan, 67-71				
		1967	1968	1969	1970	1971
1. Gross National Product	P	892.34	954.80	1021.64	1093.15	1169.67
	A	995.16	1127.32	1306.19	1422.33	1566.91
Rate of Growth	P	7.0	7.0	7.0	7.0	7.0
	A	8.9	13.3	15.9	8.9	10.2
2. Private Consumption Expenditure	P	693.02	722.09	760.75	802.58	848.86
	A	783.92	873.58	969.91	1077.16	1196.62
GNP Share	P	77.7	75.6	74.4	73.4	72.6
	A	78.8	77.5	74.3	75.8	76.4
3. Government Consumption Expenditure	P	120.64	138.14	142.72	147.48	152.41
	A	93.42	105.64	118.53	126.48	141.69
GNP Share	P	13.5	14.5	14.0	13.5	13.0
	A	9.4	9.4	9.1	8.9	9.0
4. Gross Investment	P	159.81	176.79	195.03	215.44	233.00
	A	241.72	344.12	451.47	455.58	483.46
GNP Share	P	17.9	18.5	19.1	19.7	19.9
	A	24.2	30.5	34.5	32.0	30.9
5. Exports	P	122.51	139.04	155.52	171.53	190.74
	A	141.83	200.83	264.95	325.75	392.08
GNP Share	P	13.7	14.6	15.2	15.7	16.3
	A	14.3	17.8	20.3	22.9	25.0
6. Imports	P	203.64	221.26	232.38	243.88	255.34
	A	274.05	399.93	498.82	548.95	658.67
GNP Share	P	22.8	23.2	22.7	22.3	21.8
	A	27.5	35.5	38.2	38.6	42.0
7. Net Factor Income from the Rest of the World	A	21.5	22.2	23.0	10.2	2.3

(continued)

A. National Income Aggregates, page 3

		Third Five-Year Plan. 72-76				
		1972	1973	1974	1975	1976
1. Gross National Product	P	1716.2	1862.1	2020.4	2192.1	2378.4
	A					
Rate of Growth	P	9.0	8.5	8.5	8.5	8.5
	A					
2. Private Consumption Expenditure	P	1254.1	1349.5	1443.2	1532.8	1626.1
	A					
GNP Share	P	70.0	69.4	68.4	67.0	65.5
	A					
3. Government Consumption Expenditure	P	162.5	180.1	198.1	220.2	242.5
	A					
GNP Share	P	11.8	12.0	12.2	12.5	12.7
	A					
4. Gross Investment	P	496.5	529.0	569.0	620.20	678.2
	A					
GNP Share	P	25.3	24.8	24.6	24.7	24.9
	A					
5. Exports	P	532.3	656.8	788.2	925.1	1[illegible].3
	A					
GNP Share	P	20.3	23.1	25.5	27.6	29.0
	A					
6. Imports	P	731.4	836.8	949.1	1070.3	1203.1
	A					
GNP Share	P	27.9	29.4	30.7	31.9	33.0
	A					
7. Net Factor Income from the Rest of the World						

Source: EPB, The Five-Year Economic Plans. 1962, 1966, 1971.

B. Input-Output Aggregates in the 1968 I-O Table:
Domestic, Competitive and Noncompetitive Imports Compared

	Business consumption					Households consumption				
	D	M^c	M^{nc}	M	Total	D	M^c	M^{nc}	M	Total
1. AG	179.9				179.9	413356.7	10152.6	119.6	10272.2	423628.9
2. PF	4242.9				4242.9	113907.8	4680.6		4680.6	118588.4
3. MI						1309.3				1309.3
4. TE						82230.2	4923.8		4923.8	87154.0
5. WO						3974.5	2.3		2.3	3976.8
6. CH	957.8	87.9		87.9	1045.7	23185.6	212.3	216.0	428.3	23613.9
7. FU						21673.6				21673.6
8. NM	31.1	27.2		27.2	58.3	2209.3	26.7		26.7	2236.0
9. ME						2399.3	922.7		922.7	3322.0
10. MA						19105.8	1029.6		1029.6	20135.4
11. CC	24365.0	174.3		174.3	24539.3	96830.8	647.6	53.4	701.0	97531.8
12. CO										
13. EW						9098.1				9098.1
14. BH						60497.8				60497.8
15. TR	757.1				757.1	70532.1	279.6		279.6	70811.7
16. TS	18746.0				18746.0	270244.8				270244.8
Total	49279.8	289.4		289.4	49569.2	1190555.7	22877.8	389.0	23266.8	1213822.5

D: domestic

Unit: In million won at 1968 prices

(continued)

B. Input-Output Table, 1968, page 2

	Total consumption ($C^b + C^h$)					Government consumption				
	D	M^c	M^{nc}	M	Total	D	M^c	M^{nc}	M	Total
1. AG	413536.6	10152.6	119.6	10272.2	423808.8	1164.1	87.2		87.2	1251.3
2. PF	118150.7	4680.6		4680.6	122831.3	144.4				144.4
3. MI	1309.3				1309.3	200.8				200.8
4. TE	82230.2	4923.8		4923.8	87154.0	158.8	24.2		24.2	183.0
5. WO	3974.5	2.3		2.3	3976.8	504.2	50.5		50.5	554.7
6. CH	24143.4	300.2	216.0	516.2	24659.6	1463.5	30.3	193.9	224.2	1687.7
7. FU	21673.6				21673.6	1269.6	0.7	2.0	2.7	1272.3
8. NM	2240.4	53.9		53.9	2294.3	129.5	2.0		2.0	131.5
9. ME	2399.3	922.7		922.7	3322.0	178.4	39.4	5.9	45.3	223.7
10. MA	19105.8	1029.6		1029.6	20135.4	1333.6	95.6	586.3	681.9	2015.5
11. CC	121195.8	821.9	53.4	875.3	122071.1	9015.3	4610.0	405.1	5015.1	14030.4
12. CO						7931.2				7931.2
13. EW	9098.1				9098.1	1909.1				1909.1
14. BH	60497.8				60497.8	5680.0				5680.0
15. TR	71289.2	279.6		279.6	71568.8	4104.6	606.0		606.0	4710.6
16. TS	288990.8				288990.8	40550.8	2626.9		2626.9	43177.7
Total	1239835.5	23167.2	389.0	23556.2	1263391.7	75737.9	8172.8	1193.1	9365.9	85103.8

(continued)

B. Input-Output Table, 1968, page 3

	Fixed capital formation					Increase in stocks					Exports
	D	M^c	M^{nc}	M	Total	D	M^c	M^{nc}	M	Total	E
1. AG						-13148.7	2284.6	121.7	2406.3	-10742.4	5979.7
2. PF						1664.1	120.5		120.5	1784.6	12274.3
3. MI						-411.3	59.1		59.1	-352.2	8583.0
4. TE						21439.4	400.8	432.3	833.1	22272.5	52244.6
5. WO	1381.5	103.1		103.1	1484.6	1194.6	78.0		78.0	1272.6	18323.3
6. CH						1977.8	428.0	1013.5	1441.5	3419.3	829.9
7. FU						2220.8	50.9	-221.6	-170.7	2050.1	1968.8
8. NM						-6813.5	103.5		103.5	-6710.0	1861.2
9. ME						653.0	452.8	169.6	622.4	1275.4	3653.6
10. MA	45298.6	71882.6	44043.0	115925.6	161224.2	3862.7	863.1	7329.4	8192.5	12055.2	6144.2
11. OC	513.6	857.6	1257.5	2115.1	2628.7	10387.2	255.8	278.0	533.8	10921.0	47166.8
12. CO	213610.0				213610.0						8042.4
13. EW											1096.5
14. BH	5516.9				5516.9						3983.0
15. TR	501.5				501.5	14.1				14.1	29822.2
16. TS	20119.6				20119.6	1968.5	331.9		331.9	2300.4	15277.2
Total	286941.7	72843.3	45300.5	118143.8	405085.5	25008.7	5429.0	9122.9	14551.9	39560.6	217250.7

(continued)

B. Input-Output Table, 1968, page 4

	Total final demand					Imports				
	D	M^c	M^{nc}	M	Total	X	M^c	M^{nc}	M	S.D.
1. AG	407531.7	12524.4	241.3	12765.7	420297.4	622886.7	34219.5	33694.6	67914.1	-1055.7
2. PF	132233.5	4801.1		4801.1	137034.6	173848.6	10189.1		10189.1	-254.7
3. MI	9681.8	59.1		59.1	9740.9	44276.9	2729.2		2729.2	-39.5
4. TE	156073.0	5348.8	432.3	5781.1	161854.1	237994.3	19023.4	21065.6	40089.0	-1526.5
5. WO	25378.7	233.9		233.9	25612.6	53206.5	1024.6		1024.6	106.8
6. CH	28414.0	758.5	1423.4	2181.9	30595.9	69757.7	37524.2	31465.7	68989.9	-143.4
7. FU	27132.8	51.6	-219.6	-168.0	26964.8	69224.6	3534.4	14746.5	18280.9	-62.1
8. NM	-2582.4	159.4		159.4	-2423.0	45019.7	3665.0		3665.0	109.4
9. ME	6884.3	1414.9	175.5	1590.4	8474.7	78561.5	31388.0	17618.7	49006.7	-162.4
10. MA	75744.9	73870.9	51958.7	125829.6	201574.5	131810.4	91217.7	64392.9	155610.6	1136.1
11. OC	188279.5	6545.3	1994.0	8539.3	196818.8	274942.0	28458.2	10910.8	39369.0	-381.2
12. CO	229583.6				229583.6	256714.7				3089.1
13. EW	12103.7				12103.7	41220.5				-232.5
14. BH	75677.7				75677.7	94386.7	2710.7		2710.7	-24.2
15. TR	105731.6	885.6		885.6	106617.2	163964.4	2185.1		2185.1	-401.0
16. TS	366906.9	2958.8		2958.8	369865.7	511528.6	3430.1		3430.1	-158.2
Total	1844775.3	109612.3	56005.5	165617.9	2010393.1	2869343.8	271299.2	193894.8	465194.0	0.0

S.D.: Statistical discrepancy

C. Projection of Private Consumption Demand to 1980

Sector	1968	1969	1970	1971	1972	1973	1974
1. Agriculture	360081	357674 (381669)	374783 (405703)	441301	469000	499468	532984
2. Processed foods	111373	140765 (135839)	163922 (163079)	203422	234814	269346	307330
3. Mining	2684	1890 (2960)	2801 (3268)	3724	4079	4469	4898
4. Textiles	69596	80906 (75563)	92476 (82207)	92047	99704	108127	117391
5. Wood products	4476	4761 (4944)	4778 (5465)	6236	6836	7496	8223
6. Chemical products	22751	31691 (27807)	33807 (33437)	41775	48263	55399	63250
7. Fuel	20263	19679 (24014)	22233 (28190)	34375	39187	44481	50304
8. Non-metallic products	2078	1784 (2272)	1920 (2488)	2808	3057	3331	3632
9. Metallic products	5069	6712 (5653)	6042 (6302)	7265	8013	8837	9743
10. Machinery	12518	15287 (17128)	18991 (22260)	29862	35777	42283	49440
11. Other consumer products	118251	133970 (140477)	163588 (165222)	201872	230390	261732	296267
12. Construction							
13. Electricity & Water	6164	7020 (7572)	9025 (9140)	11463	13270	17444	19849
14. Banking & Housing	40213	43872 (43574)	46119 (47316)	52857	57170	61913	67131
15. Transportation & Communication	41360	48093 (50433)	52795 (60535)	75496	87137	99943	114029
16. Trade & Services	68956	75828 (77434)	83880 (86873)	100853	111731	123697	136859
Statistical discrepancy	-12253	-22					
Total	873580	969910 (997339)	1077160 (1121485)	1305356	1448428	1505780	1778925

* Projected C_t for '69 and '70 are compared with actual C_t.
Figures in the parenthese are projected ones.

(continued)

C. Projection of Private Consumption Demand to 1980 (page 2)

Sector	1975	1976	1977	1978	1979	1980	Average annual rate of growth
1. Agriculture	569848	610415	655010	704088	758050	817426	0.0811
2. Processed foods	349110	395086	445627	501249	562407	629700	0.1441
3. Mining	5370	5889	6460	7089	7780	8540	0.1179
4. Textiles	127582	138796	151123	164690	179606	196020	0.0780
5. Wood products	9021	9900	10867	11930	13099	14386	0.1165
6. Chemical products	71884	81386	91832	103327	115967	129874	0.1284
7. Fuel	56710	63758	71506	80033	89409	99726	0.1620
8. Non-metallic products	3963	4328	4728	5169	5654	6188	0.1242
9. Metallic products	10740	11836	13042	14368	15827	17432	0.1118
10. Machinery	57313	65975	75498	85979	97502	110181	0.1922
11. Other consumer products	334221	375987	421901	472430	527988	589120	0.1378
12. Construction							
13. Electricity & Water	19849	22496	25405	28607	32127	36001	0.1484
14. Banking & Housing	72870	79186	86128	93769	102170	111414	0.0922
15. Transportation & Communication	129523	149572	165315	185942	208622	233577	0.1603
16. Trade & Services	151337	167268	184782	204056	225248	248567	0.1147
Total	1969341	2181878	2409224	2662726	2941456	3248152	0.1167

Unit: In million won at 1965 prices

D. Projection of Business Consumption Demand to 1980

Sector	elasticities	1966	1968	1969	1970	1971	1972
1. Agriculture	-4.322454	171.3	131.6	135.4	108.4	108.4	108.4
2. Processed foods	4.480250	1081.6	3738.2	8158.1	11640.4	17580.4	22301.0
6. Chemical products	2.213845	438.4	1043.6	1951.5	2166.3	2975.5	3634.3
8. Non-metallic products	5.411191	30.9	43.2	10.1	25.4	125.3	153.3
11. Other consumer products	1.243546	13070.4	19352.8	22551.9	28579.7	36371.1	42175.0
15. Transportation & Communication	0.853865	320.9	429.0	488.6	530.3	731.3	834.4
16. Trade & Services	1.509313	8989.1	12589.7	14483.4	16702.2	21379.4	24376.9
Total		24102.6	37328.1	47779.0	59752.7	79271.4	93583.3

Unit: In million won at 1965 prices

(continued)

D. Projection of Business Consumption Demand to 1980

Sector	elasticities	1966	1968	1969	1970	1971	1972
1. Agriculture	-4.322454	171.3	131.6	135.4	108.4	108.4	108.4
2. Processed foods	4.480250	1081.6	3738.2	8158.1	11640.4	17580.4	22301.0
6. Chemical products	2.213845	438.4	1043.6	1951.5	2166.3	2975.5	3634.3
8. Non-metallic products	5.411191	30.9	43.2	10.1	25.4	125.3	153.3
11. Other consumer products	1.243546	13070.4	19352.8	22551.9	28579.7	36371.1	42175.0
15. Transportation & Communication	0.853865	320.9	429.0	488.6	530.3	731.3	834.4
16. Trade & Services	1.509313	8989.1	12589.7	14483.4	16702.2	21379.4	24376.9
Total		24102.6	37328.1	47779.0	59752.7	79271.4	93583.3

Unit: In million won at 1965 prices

(continued)

D. Projection of Business Consumption Demand to 1980 (page 2)

Sector	1973	1974	1975	1976	1977	1978	1979	1980
1. Agriculture	108.4	108.4	108.4	108.4	108.4	108.4	108.4	108.4
2. Processed foods	27493.9	33205.9	39488.7	46402.4	54002.7	62367.0	71563.9	81683.3
6. Chemical products	4359.0	5156.3	6033.1	6998.0	8058.8	9226.1	10509.7	11922.0
8. Non-metallic products	184.2	218.0	255.3	296.3	341.3	390.9	445.5	505.6
11. Other consumer products	48553.6	55582.1	63306.4	71806.5	81150.8	91434.3	102741.3	115182.7
15. Transportation & Communication	947.8	1072.6	1209.8	1387.4	1526.8	1709.5	1910.4	2131.4
16. Trade & Services	27674.4	31301.3	35290.9	39681.0	44507.2	49818.4	55658.2	62084.0
Total	109321.3	126644.6	145692.6	166680.0	189696.0	215054.6	242937.4	273617.4

Unit: In million won at 1965 prices

E. Projection of Government Consumption Demand to 1980

Sector	1968	1969	1970	1971	1972	1973	1974
1. Agriculture	754.1	807.0	839.5	901.8	956.9	1020.4	1090.3
2. Processed foods	87.0	91.4	94.1	99.2	103.7	108.9	114.7
3. Mining	121.1	59.1	21.0	21.0	21.0	21.0	21.0
4. Textiles	110.3	115.9	119.3	125.9	131.8	138.5	145.9
5. Wood products	334.3	354.7	367.3	391.3	412.5	437.0	464.0
6. Chemical products	1017.2	1087.0	1130.1	1212.5	1285.2	1369.3	1461.7
7. Fuel	766.8	818.2	849.8	910.5	964.0	1025.8	1093.8
8. Non-metallic products	79.2	98.2	109.9	132.4	152.2	175.0	200.2
9. Metallic products	134.8	121.5	113.2	97.5	83.6	67.6	49.9
10. Machinery	1214.7	1513.4	1697.3	2049.7	2360.8	2720.0	3115.1
11. Other consumer products	8455.6	11830.8	13909.2	17890.7	21406.3	25465.6	29931.1
12. Construction	4779.9	6811.7	8062.8	10459.5	12575.8	15019.3	17707.4
13. Electricity & Water	1150.6	1236.3	1289.0	1390.1	1479.3	1582.3	1695.7
14. Banking & Housing	3423.1	3022.9	3064.1	2801.9	2570.5	2303.2	2009.3
15. Transportation & Communication	2838.9	3076.8	3223.2	3503.7	3751.4	4037.4	4352.1
16. Trade & Services	26021.5	28837.3	30571.2	33892.8	36825.6	40212.1	43937.5
Sub-total	51288.9	59882.1	65460.8	75880.4	85080.4	95703.5	107389.4
Value added	54346.1	58650.9	61014.2	65809.6	70043.6	74932.5	80310.6
Total	105635.0	118533.0	126475.0	141690.0	155124.0	170636.0	187700.0

Unit: In million won at 1965 constant prices

(continued)

E. Projection of Government Consumption Demand, page 2

Sector	1975	1976	1977	1978	1979	1980
1. Agriculture	1167.2	1251.8	1344.8	1447.2	1559.8	1683.6
2. Processed foods	121.0	127.9	135.6	144.0	153.2	163.4
3. Mining	21.0	21.0	21.0	21.0	21.0	21.0
4. Textiles	154.1	163.0	172.9	183.7	195.7	208.8
5. Wood products	493.6	526.2	562.1	601.6	645.0	692.8
6. Chemical products	1563.4	1675.2	1798.2	1933.6	2082.4	2246.2
7. Fuel	1168.6	1250.9	1341.4	1440.9	1550.4	1670.9
8. Non-metallic products	227.8	258.3	291.7	328.5	369.0	413.6
9. Metallic products	30.5	9.1	9.1	9.1	9.1	9.1
10. Machinery	3549.8	4028.0	4553.9	5132.5	5768.9	6468.9
11. Other consumer products	34842.9	40246.0	46189.5	52727.3	59918.8	67829.4
12. Construction	20664.2	23916.6	27494.4	31429.9	35758.9	40520.8
13. Electricity & Water	1820.3	1957.5	2108.3	2274.3	2456.8	2657.6
14. Banking & Housing	1685.9	1330.2	938.9	508.4	35.0	35.0
15. Transportation & Communication	4698.1	5078.8	5497.6	5958.2	6464.9	7022.3
16. Trade & Services	48035.2	52542.8	57501.1	62955.3	68954.8	75554.2
Sub-total	120243.6	134383.2	149960.5	167095.4	185943.6	207197.3
Value added	86226.4	92733.8	99868.5	107716.6	116349.4	125324.7
Total	206470.0	227117.0	249829.0	274812.0	302293.0	332522.0

F. Estimation of Coefficients of Major Variables, 1960-1970

Sector	θ_i	α_i	β_i	γ_i	δ_i
1. Agriculture	-0.287	0.022	0.081	0.046	
2. Processed foods	-0.113	0.027	0.071	1.239	-850.26
3. Mining	0.562	0.248	1.032	0.678	
4. Textiles	0.314	0.218	0.210	0.618	853.72
5. Wood products	0.761	0.381	0.765	0.446	
6. Chemical products	1.884	0.026	0.360	0.297	
7. Fuel	-1.477	0.023	0.400	0.373	2410.04
8. Non-metallic products	1.162	0.027	0.044	1.785	750.33
9. Metallic products	1.183	0.084	0.629	0.510	-5888.11
10. Machinery	0.518	0.100	1.562	0.305	-20679.92
11. Other consumer products	-0.370	0.112	0.102	0.270	649.23
12. Construction	0.971	0.031		0.127	
13. Electricity & Water	0.187	0.027		5.110	
14. Banking & Housing	0.090	0.042	0.029	6.129	
15. Transportation & Communication	0.267	0.182	0.013	0.894	
16. Trade & Services	0.573	0.030	0.007	0.220	

G. Comparison of Estimated and Actual Outputs

Sector	A Actual Outputs, 1968	B $a_{ij}X_j$ tested	C Estimated	(B - A)/A	(C - A)/A
1. Agriculture	622886.7	624209.0	626861.4	0.0021	0.0064
2. Processed foods	173848.6	174199.8	162472.7	0.0020	-0.0654
3. Mining	44276.9	44173.2	20557.6	-0.0023	-0.5357
4. Textiles	237994.3	240686.9	223009.8	0.0113	-0.0630
5. Wood products	53206.5	52831.1	23899.6	-0.0071	-0.5508
6. Chemical products	69757.7	70036.9	107759.3	0.0040	0.5448
7. Fuel	69224.6	69277.0	61903.4	0.0008	-0.1058
8. Non-metallic products	45019.7	44372.8	45845.3	-0.0144	0.0183
9. Metallic products	78561.5	77605.5	68105.6	-0.0122	-0.1331
10. Machinery	131810.4	129915.8	101558.2	-0.0144	-0.2295
11. Other consumer products	274942.0	275549.2	267358.8	0.0022	-0.0276
12. Construction	256714.7	253637.1	252921.6	-0.0120	-0.0148
13. Electricity & Water	41220.5	41441.3	40410.7	0.0054	-0.0196
14. Banking & Housing	94386.7	94466.9	93564.2	0.0008	-0.0087
15. Transportation & communication	163964.4	164250.4	161368.4	0.0017	-0.0158
16. Trade & Services	511528.6	511447.8	503033.6	-0.0002	-0.0166
Total	2869343.8	2867920.7	2760630.2	-0.0005	-0.0379

Unit: Amount in million won at 1968 prices

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AN ECONOMETRIC FORECASTING MODEL OF THE KOREAN ECONOMY

Heeyhon Song

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PREFACE

This paper is one in the series of continuing KDI research works, which are designed to aid in the formulation of sound public policies and to promote public understanding of issues of the Korean economy.

This paper is a progress report of our research project which will cover a system of aggregate supply and demand equations of the Korean economy. The system presented in this paper is the most acceptable one, so far found, in terms of economic experience and statistical validity. The forecasting ability of the model was critically tested through both interpolation of values within the sample period and extrapolation outside the sample period. The primary objective of this study is to develop a structural macro-model which will be able to simulate economic processes and to experiment with the ultimate consequences of alternative sets of policy combinations. An accurate projection of the implication of given sets of policy decisions will be of great help in formulating the Korean annual plan.

The interpretations and conclusion in this paper are those of the author or authors and do not represent the views of the Korea Development Institute. Finally, I would like to extend our appreciation to those within and outside of this Institute who have participated in these endeavours.

Mahn Je Kim
President

AN ECONOMETRIC FORECASTING MODEL OF THE KOREAN ECONOMY*

by

Heeyhon Song

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I. INTRODUCTION

Since the major revision of Korean national income accounts was published in 1967, a number of macro-econometric models have been developed and some of them have already been published.[1] However, no applicable quarterly macro-model could have been constructed so far, for the quarterly national income statistics were not available until July, 1971. Besides this study, a quarterly monetary model is in the process of construction by the research department, the Bank of Korea.

The primary objective of this research is to estimate the structural equations of the Korean economy in rather aggregate forms, as a starting-point of building a short-term forecasting model. Although the size of the model is relatively small, 11 stochastic equations and seven identities, its forecasting ability seems rather powerful. The simulation of some of the economic processes through the model makes it possible to experiment with the ultimate consequences of alternative sets of policy adjustments. An accurate projection with given set of policy decisions will be of great help in formulating the Korean annual plan (i.e., the Overall Resources Budget).

The model consists essentially of two parts: (1) the description of an aggregate demand structure by linear equations

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[1] Kim and Nam [12]; Adelman and Kim [2]; Norton [18]; Kim, et. al [13].

and (2) the specifications of aggregate production functions by non-linear forms. Since only real data are available for the quarterly national income statistics, the model is specified in real terms. To handle the combined model of linear and non-linear relationships, a flexible procedure, i.e., a recursive and iterative solution, has been adopted. The solution proceeds period by period (two quarters as a unit of period) with iteration adjustment. It appears that one quarter would be too short a time span to be adjusted due to short-run random errors.

The second section of the paper presents the estimated equations which, for the sample period of 1962—1971, are believed to be the most reliable descriptions of the structure of the Korean economy among alternative equations. Next, the natures of the equations are discussed in terms of economic experience and statistical validity. The fourth section is devoted to the critical tests of the model for its predictive ability through the generation of various forecasts. Finally, the paper is closed with some concluding remarks.

II. THE MODEL

The observed sample data include the quarters from I-1960 to IV-1971, and for each equation, the included sample data are specified. For lagged values some earlier quarters were used. The model is in essence recursive system, except for the simultaneous relation between value added in the non-primary sector and the level of the wholesale price index. From a statistical point of view, the recursive system makes it acceptable to use the ordinary least squares to estimate structural parameters, if there is no correlations between error terms of each equation in the system.

1. List of Variables

A. Current Endogenous Variables

V^m = Total value added in manufacturing, billions of 1965 wons

V^{na} = Total value added in the non-primary sector (industries other than agriculture, forestry and fishery), billions of 1965 wons

$V^{na'}$ = Percentage change in V^{na} from the past to the current quarter.

V = Total value added, billions of 1965 wons

V^d = Total disposable income, billions of 1965 wons

C^p = Private consumption expenditures, billions of 1965 wons

C = Total consumption expenditures, billions of 1965 wons

I^{meq} = Fixed capital formation in machinery and equipments, billions of 1965 wons

I^h = Fixed capital formation in residential buildings, billions of 1965 wons

I^{nh} = Fixed capital formation in non-residential buildings, billions of 1965 wons

I^f = Total fixed capital formation, billions of 1965 wons

M^{meq} = Imports of machinery and equipments, billions of 1965 wons

M^i = Imports of intermediate goods. billions 1965 wons

M^c = Total commodity imports, billions of 1965 wons

M = Total imports, billions of 1965 wons

I^i = Increase in stocks, billions of 1965 wons

P = Wholesale price indexes for all commodities (1965=100)

P' = Percentage changes in P from the past quarter to the current quarter

B. Stocks

K^{na} = Capital stock in the non-primary sector at end-of-quarter, billions of 1965 wons

K^m = Capital stock in manufacturing at end-of-quarter, billions of 1965 wons

St^h = Residential building stock, billions of 1965 wons

C. Exogenous Variables

MSN = Currency in circulation and total demand deposits, billions of current wons

MSN' = Percentage changes in MSN from the past quarter to the current quarter

MS = Currency in circulation and total demand deposits, billions of current wons, deflated by wholesale price index (1965=100)

R^m = Nominal import exchange rate (won/dollar)

$R^{m'}$ = Percentage change in R^m from the past quarter to the current quarter

P^m = Imports unit value index number (1965=100)

TR = Tariff rate = $\left(\frac{\text{Import custom duties}}{\text{Total commodity imports}} \right)$

P^{rm} = Ratio of effective import prices to domestic wholesale prices, $(R^m + TR) \times \frac{P^m}{P}$

FL = Inflow of long-term foreign loans, billions of 1965 wons

E^c = Total commodity exports, billions of 1965 wons

E = Total exports, billions of 1965 wons

G^i = Government investment and development loan, billions of 1965 wons

C^g = Government consumption expenditures, billions of 1965 wons

I^o = Private non-building and electric construction, billions of 1965 wons

I^g = Government constructions, billions of 1965 wons

M^g = Grain imports, billions of 1965 wons

M^s = Service imports, inclusion of net factor income, billions of 1965 wons

L^{na} = Employment in the non-primary sector, million persons

L^m = Employment in manufacturing, thousand persons

W^m = Wage rates in manufacturing (1965=100)

V^a = Total value added in agriculture, fishery, and forestry

T = Tax revenues

P^r = Rice price index

$P^{r'}$ = Percentage changes in P^r from the past quarter to the current quarter

P^u = Public utility price index

$P^{u'}$ = Percentage changes in P^u from the past quarter to the current quarter

t = Time in units of quarters

D1 = 1 in the first quarter, 0 otherwise

D2 = 1 in the second quarter, 0 otherwise

D3 = 1 in the third quarter, 0 otherwise

D4 = 1 in the fourth quarter, 0 otherwise

A_i = Distributed lag weights (Almon weights)

Normalized weights are $A_0 = 0.074$; $A_1 = 0.132$; $A_2 = 0.170$; $A_3 = 0.183$; $A_4 = 0.171$; $A_5 = 0.138$ $A_6 = 0.092$; $A_7 = 0.041$

2. Estimated Structural Equations and Identities

In the equations written below the figures in the parentheses under each coefficient are estimated standard errors. R^2 is multiple correlation coefficient and DW is Durbin-Watson Statistic. In addition to statistical validity, forecasting ability also has been taken into account in the process of choosing structural equations. The structural equations with asterisk were used for the simulation experiment presented in Section IV.

A. Estimated Structural Equations

$$(1\text{-}1) \quad \log\left(\frac{V^{na}}{L^{na}}\right) = \underset{(0.894)}{0.215} + \underset{(0.130)}{0.291} \log\left(\frac{K^{na}_{-1}}{L^{na}}\right) + \underset{(0.074)}{0.241} \log\left(\frac{M^{i}}{L^{na}}\right)$$

$$+ \underset{(0.078)}{0.152} \log\left(\frac{MS^{i}}{L^{na}}\right) + \underset{(0.002)}{0.007}\, t$$

$R^2 = 0.921 \qquad DW = 2.64$

Sample period = IV-1962 — IV-1971

where $MS^{i} = 0.580\, MS + 0.330\, MS_{-1} + 0.090\, MS_{-2}$

$$(1\text{-}2)^{*} \quad \log\left(\frac{V^{na}}{L^{na}}\right) = \underset{(0.890)}{0.205} + \underset{(0.124)}{0.323} \log\left(\frac{K^{na}_{-1}}{L^{na}}\right) + \underset{(0.088)}{0.302} \log\left(\frac{MS^{i}}{L^{na}}\right)$$

$$+ \underset{(0.004)}{0.010}\, t + \underset{(0.016)}{0.205}\, D2 + \underset{(0.022)}{0.090}\, D3 + \underset{(0.015)}{0.135}\, D4$$

$R^2 = 0.991 \qquad DW = 2.64$

Sample period = IV-1965 — IV-1971

$$(1\text{-}3)^{*}\quad \log\left(\frac{V^m}{L^m}\right) = \underset{(0.259)}{-0.524} + \underset{(0.114)}{0.212}\log\left(\frac{K^m_{-1}}{L^m}\right) + \underset{(0.104)}{0.190}\log\left(\frac{MS^i}{L^m}\right)$$

$$+ \underset{(0.097)}{0.294}\log\left(\frac{M^d}{L^m}\right) + \underset{(0.003)}{0.013}\,t$$

$R^2 = 0.914$ DW = 1.94

Sample period = III-1962—IV-1971

$$(2\text{-}1)\quad O^p = \underset{(5.854)}{-1.063} + \underset{(0.016)}{0.248}\,V^d_{-1} + \underset{(0.016)}{0.181}\,V^d_{-2} + \underset{(0.015)}{0.187}\,V^d_{-3}$$

$$+ \underset{(0.015)}{0.350}\,V^d_{-4}$$

$R^2 = 0.971$ DW = 1.43

Sample period = I-1961—IV-1971

$$(2\text{-}2)^{*}\quad O^p = \underset{(8.454)}{18.934} + \underset{(0.023)}{0.192}\,V^d_{-1} + \underset{(0.023)}{0.127}\,V^d_{-2} + \underset{(0.022)}{0.133}\,V^d_{-3}$$

$$+ \underset{(0.023)}{0.294}\,V^d_{-4} + \underset{(0.082)}{0.250}\,MS^c$$

$R^2 = 0.977$ DW = 1.87

Sample period = I-1961—IV-1971

where $MS^c = 0.540\,MS + 0.340\,MS_{-1}$

$+ 0.120\,MS_{-2}$

$$(3\text{-}1)^{*} \quad I^{f} = \underset{(4.392)}{14.394} + \underset{(1.311)}{1.516} \sum_{i=0}^{l} A_i \cdot \Delta V^{na}_{-i-2} + \underset{(0.074)}{0.237}\, MS^{1}$$

$$+ \underset{(0.224)}{1.009}\, FL - \underset{(3.602)}{19.339}\, D1$$

$R^2 = 0.943$ DW = 2.65

Sample period = III-1962—IV-1971

$$(3\text{-}2)^{*} \quad I^{h} = \underset{(48.329)}{172.269} + \underset{(0.037)}{0.185}\, V^{na^{1}} - \underset{(0.042)}{0.153}\, St^{h}_{-1} - \underset{(0.512)}{1.659}\, D1$$

$R^2 = 0.901$ DW = 2.04

Sample period = II-1961—IV-1971

where $V^{na^{1}} = 0.195\, V^{na}_{-2}$

$+ 0.352\, V^{na}_{-3}$

$+ 0.453\, V^{na}_{-4}$

$$(3\text{-}3) \quad I^{h} = \underset{(0.595)}{0.248} + \underset{(0.022)}{0.037}\, \Delta V^{na}_{-2} + \underset{(0.028)}{0.057}\, \Delta V^{na}_{-3} + \underset{(0.023)}{0.086}\, \Delta V^{na}_{-4}$$

$$+ \underset{(0.165)}{0.342}\, I^{h}_{-1} + \underset{(0.012)}{0.029}\, MS^{h} - \underset{(1.045)}{2.566}\, D1$$

$R^2 = 0.888$ DW = 2.12

Sample period = III-1963—IV-1971

where $MS^{h} = 0.318\, MS_{-1}$

$+ 0.465\, MS_{-2}$

$+ 0.217\, MS_{-3}$

$$(3\text{-}4)^{*} \quad I^{nh} = \underset{(0.535)}{1.675} + \underset{(0.017)}{0.064}\,\Delta V^{na}_{-2} + \underset{(0.022)}{0.081}\,\Delta V^{na}_{-3} + \underset{(0.021)}{0.071}\,\Delta V^{na}_{-4}$$

$$+ \underset{(0.014)}{0.575}\, I^{nh}_{-1} + \underset{(0.010)}{0.018}\, MS^{nh} - \underset{(0.878)}{3.083}\, D1$$

$R^2 = 0.894$ DW = 2.21

Sample period = III-1961—IV-1971

where $MS^{nh} = 0.361\, MS_{-1}$

$+ 0.464\, MS_{-2}$

$+ 0.175\, MS_{-3}$

$$(3\text{-}5) \quad I^{nh} = \underset{(0.752)}{2.818} + \underset{(0.021)}{0.050}\,\Delta V^{na}_{-2} + \underset{(0.026)}{0.062}\,\Delta V^{na}_{-3} + \underset{(0.024)}{0.051}\,\Delta V^{na}_{-4}$$

$$+ \underset{(0.153)}{0.359}\, I^{nh}_{-1} + \underset{(0.012)}{0.030}\, MS^{nh} - \underset{(1.087)}{3.361}\, D1$$

$R^2 = 0.866$ DW = 1.90

Sample period = III-1963—IV-1971

$$(3\text{-}6) \quad I^{meq} = \underset{(1.301)}{7.375} + \underset{(0.494)}{1.573} \sum_{i=0}^{7} A_i\, \Delta V^{na}_{-i-2} + \underset{(0.079)}{0.581}\, FL$$

$R^2 = 0.942$ DW = 1.85

Sample period = IV-1962—IV-1971

$$(3\text{-}7)\quad I^{meq} = \underset{(1.085)}{7.958} + \underset{(0.090)}{0.231}\Delta V^{na}_{-2} + \underset{(0.101)}{0.181}\Delta V^{na}_{-3} + \underset{(0.112)}{0.241}\Delta V^{na}_{-4}$$

$$+ \underset{(0.110)}{0.213}\Delta V^{na}_{-5} + \underset{(0.072)}{0.695}\ FL$$

$R^2 = 0.947$ DW = 1.88

Sample period = IV-1961—IV-1971

$$(3\text{-}8)\quad I^{meq} = \underset{(1.364)}{8.037} + \underset{(1.471)}{3.467}\sum_{i=0}^{7} A_i \cdot \Delta V^{m}_{-i-2} + \underset{(0.104)}{0.578}\ FL$$

$R^2 = 0.935$ DW = 1.69

Sample period = IV-1962—IV-1971

$$(3\text{-}9)^*\quad I^{meq} = \underset{(1.138)}{7.970} + \underset{(0.281)}{0.691}\Delta V^{m}_{-2} + \underset{(0.297)}{0.459}\Delta V^{m}_{-3} + \underset{(0.346)}{0.591}\Delta V^{m}_{-4}$$

$$+ \underset{(0.356)}{0.556}\Delta V^{m}_{-5} + \underset{(0.096)}{0.664}\ FL$$

$R^2 = 0.944$ DW = 1.83

Sample period = IV-1961—IV-1971

$$(3\text{-}10)^*\quad I^{i} = \underset{(2.762)}{-19.231} + \underset{(0.126)}{0.168}\Delta V^{na} + \underset{(0.030)}{0.158}\Delta V^{a} + \underset{(7.483)}{94.493}\ D4$$

$R^2 = 0.982$ DW = 1.90

Sample period = II-1962—IV-1971

$$(4\text{-}1)^*\quad M^{meq} = \underset{(5.173)}{20.528} + \underset{(0.034)}{0.827}\ FL - \underset{(0.020)}{0.063}\ P^{rm}$$

$R^2 = 0.951$ DW = 1.66

Sample period = I-1962—IV-1971

$$(4\text{-}2)^* \quad M^1 = \underset{(5.079)}{7.981} + \underset{(0.024)}{0.836}\, V^m - \underset{(0.020)}{0.043}\, P^{rm}$$

$R^2 = 0.966$ DW = 2.02

Sample period = I-1960—IV-1971

$$(5\text{-}1)^* \quad P' = \underset{(0.373)}{-0.704} - \underset{(0.077)}{0.165}\, wV^{na'} + \underset{(0.040)}{0.232}\, wMSN' + \underset{(0.044)}{0.363}\, wR^m + \underset{(0.010)}{0.121}\, P^{r'} + \underset{(0.023)}{0.200}\, P^{u'}$$

$R^2 = 0.935$ DW = 1.69

Sample period = I-1965—IV-1971

where $wV^{na'}$ = a distributed-lag weighted average of the current and two past values of $V^{na'}$,

$wMSN'$ = a distributed-lag weighted average of the three past values of MSN',

$wR^{m'}$ = a distributed-lag weighted average of the current and the one past values of $R^{m'}$.

B. Identities

(6-1) $C = C^p + C^g$

(7-1) $I^f = I^{meq} + I^h + I^{nh} + I^o + I^g$

(8-1) $M^c = M^{meq} + M^i + M^g$

(9-1) $M = M^c + M^s$

(10-1) $V = C + I^f + X - M + I^i$ & SD (statistical discrepancy)

(11-1) $V^d = V - T$

(12-1) $V^{na} = V - V^a$

C. Estimating Equations for Exogenous Variables

$$I^g = -0.543 + 0.966\ G^i + 2.106\ D4$$

$$R^2 = 0.913$$

$$I^o = \alpha(I^h + I^{nh} + I^g)$$

where α is a ratio of I^o to $(I^h + I^{nh} + I^g)$

III. DISCUSSION OF THE EQUATIONS

1. Aggregate Production Equations

Two production functions were estimated, one for the non-primary sector and one for manufacturing which is a part of the non-primary sector. Due to the lack of quarterly data for investment for the other disaggregated production sectors, no attempt has been made to estimate production equations for those other sectors such as social overhead and service. The Cobb-Douglas form of the production function with constant return to scale was assumed. A multi-collinearity problem between employment and stock variables made it difficult to estimate the production function of non-constant return to scale.

The production function estimated here is a relationship between real output and inputs of utilized capital stock, man-hours worked, and a technological time trend. Since the data for man-hours worked were not available, employment was taken as labor input. The estimation of capital utilization is particularly difficult in Korea due partly to the shortage of information. It would be unrealistic, for the present, to adopt the notion of the Wharton School index of capacity utilization.[2]

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[2] Klein [15, pp. 23-24].

Production activities in developing nations are highly constrained by the scarcity of foreign resources and the limitation of domestic fund, both of which are to a large extent subject to policy adjustments. Therefore, the peaks may not well represent possible "full" capacity utilization under these peculiar circumstances. It could be quite controversial assumption, but we still assumed that, by introducing intermediate imports and money supply, the production equations would be able to reflect the variations in capacity utilization caused by the availability of intermediate imports and real cash balances.

The intermediate imports are very scarce resources in Korea as mentioned above, and short-term fluctuations in imports are rather significant, for imports are very sensitive to policy adjustment. (See Figure 1) Furthermore, it would be very expensive for producers to pile up imported raw materials for future rainy days, mainly because of high interest cost.

Real cash balances are to some extent a factor of production, and they surely facilitate the production process. As real cash balances change, the degree of capital utilization is assumed to change, and, consequently, also production.

> It is immaterial whether this value in some form of separately measured production, because of facilitation of the productive process by cash balance, ... total product changes when real cash balances change. To some extent it is clearly true that real cash balances are a factor of production; they reduce the other resources required for a given level of production, by facilitating payment.[3]

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[3] Bailey [4, p.59].

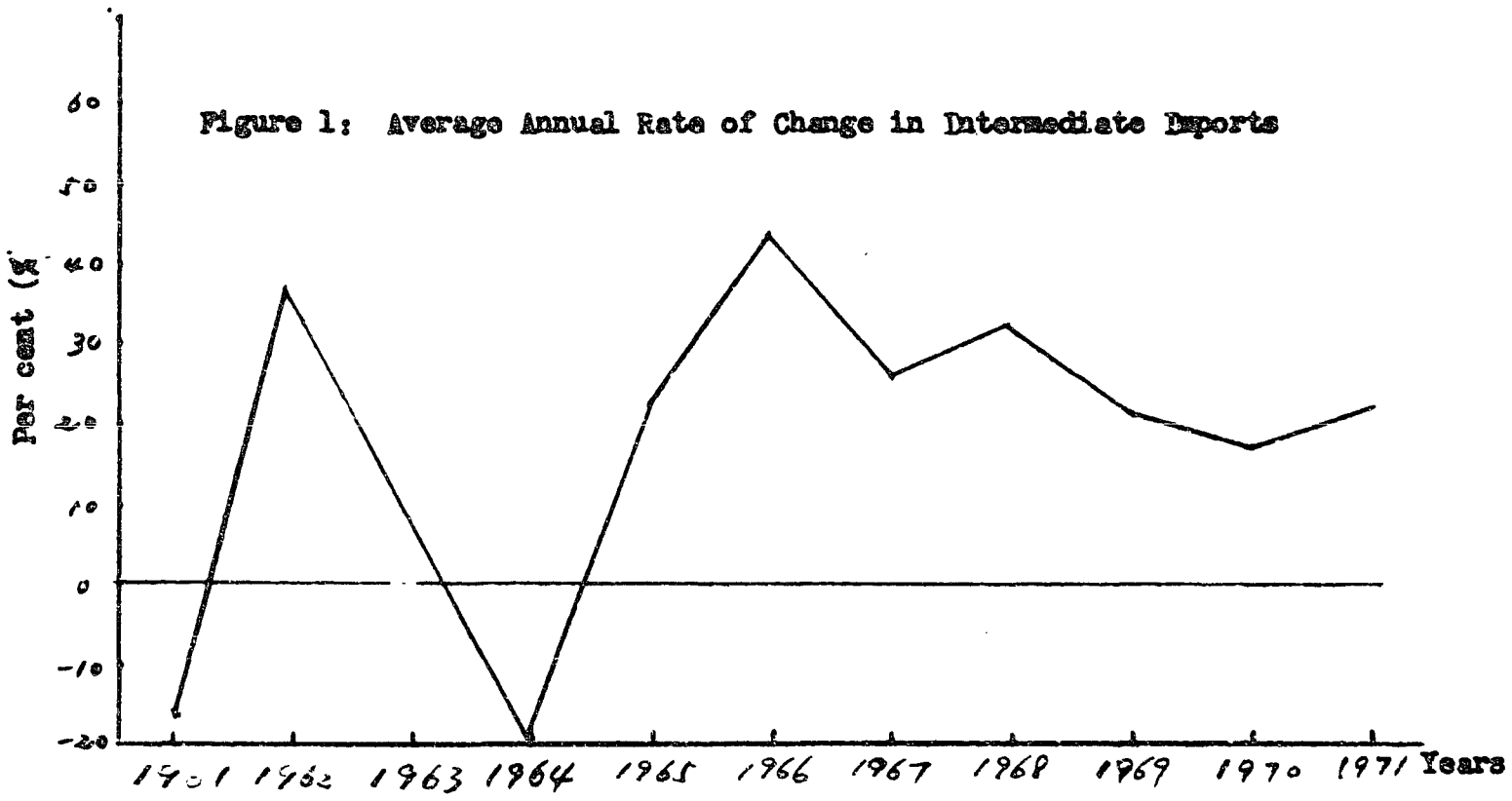

Figure 1: Average Annual Rate of Change in Intermediate Imports

The coefficients on the imports and money supply variables were thus regarded as the shares of the utilized capital stock attributable to the availabilities of imports and real money supply, respectively. Of course, in the short-run, the man-hours worked, i.e., the utilization of labor, will also be influenced by the availability of imported inputs and money supply. However, the labor force in Korea is still relatively abundant at reasonable cost, and the change in employment is much less rigid than that in capital stock. The variation of man-hours worked due to change in imports and money supply, thus, was not seriously taken into account.

Our production function will take the following forms: Neutral technical progress at rate m, for example, can be written with a single parameter α $(0<\alpha<1)$:

$$Q = e^{mt} K^{\alpha} L^{1-\alpha} \qquad \text{.....} \quad (1)$$

where K = capital input

L = labor input

t = time

By dividing (1), both sides, by L:

$$\frac{Q}{L} = e^{mt} \left(\frac{K}{L}\right)^{\alpha} \qquad \text{.....} \quad (2)$$

By derivation from (2) in logarithmic form:

$$\log \left(\frac{Q}{L}\right) = mt + \alpha \log \left(\frac{K}{L}\right) \qquad \text{.....} \quad (3)$$

Equation (3) can also be written with three parameters by introducing M^{i} and MS:

$$\log\left(\frac{Q}{L}\right) = mt + \gamma \log\left(\frac{K}{L}\right) + \delta \log\left(\frac{M^i}{L}\right) + \lambda \log\left(\frac{MS}{L}\right) \quad \ldots\ldots (4)$$

where M^i = intermediate imports

MS = real money supply

Assuming $\alpha = \gamma + \delta + \lambda$:

$$Q = e^{mt} K^{\gamma} M^{\delta} MS^{\lambda} L^{1-\alpha} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Non-Primary Aggregate Production Equation. With intermediate imports and money supply weighted by a polynomial distributed lag technique,[4] a Cobb-Douglas type of non-primary production functions were estimated in logarithm form. According to equation (1-1), the shares of capital and labor inputs were 68 per cent ($\alpha = \gamma + \delta + \lambda$) and 32 per cent ($1-\alpha$), respectively. The share of labor, 32 per cent, seemed too small because the estimated average labor costs in the non-primary sector was, over the sample period, approximately 39 per cent of the total value added.

As Figure 1 shows, since 1965 the average annual rates of changes in intermediate imports have been rather steady with a slightly downward trend. Thus, it was assumed that since 1965 variations in the availability of intermediate imports would not seriously affect capital utilization. Another assumption drawn from Figure 2 was that a distinct seasonality of non-primary production activities has been developed since 1965. Thus, reducing the sample size to 25, from IV-1965 to IV-1971 with

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[4] See footnote 12.

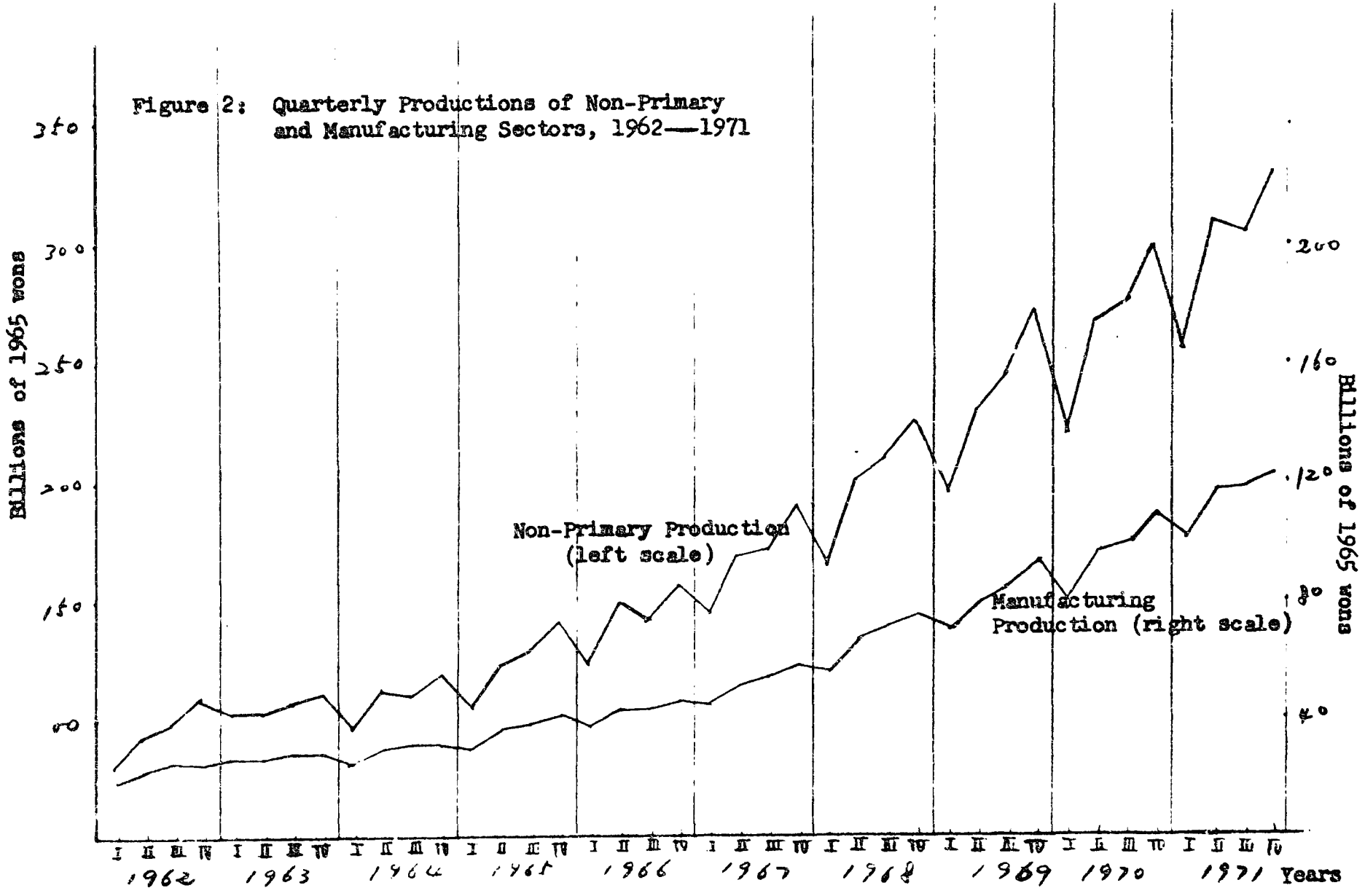

Figure 2: Quarterly Productions of Non-Primary and Manufacturing Sectors, 1962—1971

some lags, and by including seasonal variables, a new production function of the non-primary sector was estimated (1-2). The variable of intermediate imports was not included as a significant determinant, but the seasonal dummies were included, as expected. The new shares of capital and labor inputs were, according to equation (1-2), 63 per cent and 37 per cent, respectively. The labor share of 37 per cent was very close to 39 per cent, the estimated actual share of labor costs in the non-primary sector.

The imputed annual average of the marginal physical productivity of capital, over the period of 1963-1971, was 16 and 15 per cent according to equations (1-1) and (1-2), respectively.[5] Thus, by introducing nine per cent of average annual inflation,[6] the annual average of the marginal productivity of capital at current prices was estimated at approximately 24 per cent. Considering general interest rates, this rate seems reasonable.

Similarly, the annual average of the marginal physical productivity of labor over the same period of time was estimated at 58,560 and 69,540 wons at 1965 constant prices according to equations (1-1) and (1-2), respectively. These figures are very reasonable, because the average annual wage earnings in the manufacturing sector from 1963 to 1970 was, for example, approximately 66,700 wons at 1965 constant prices.

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[5] $\frac{V}{K} = \alpha \frac{Y}{K}$ $\quad \frac{V}{L} = (1-\alpha) \frac{V}{L}$

[6] Over the last eight years, 1963—1971, the average annual rate of increase in the wholesale price index was about nine per cent.

Aggregate Manufacturing Production Equation. It was assumed that the level of capital utilization in the manufacturing sector would be more sensitive to changes in the availability of imported raw materials and cash balances, than in any other sectors of the economy. In Korea, most of the intermediate imports are tied closel to manufacturing outputs. According to the 1968 mining and manufacturing census, the cost of raw materials was 54.3 per cent of the value of total shipped products. The intermediate imports of 213.1 billions of current wons in 1968 was more than 50 per cent of the total manufacturing raw material costs, 409.6 billions of current wons.

It seems reasonable to postulate that the manufacturing sector is, in regard to capital utilization, relatively more sensitive to the level of cash balances than most of the other sectors. The more money, the more additional stocks of raw materials and outputs can be maintained, together with more fund for deferred payment and market expansion. Therefore, the shares of capital which may be attributed to changes in intermediate imports and money supply are relatively larger in manufacturing than in the non-primary sector as a whole.

Since the seasonality of manufacturing production activities is not as distinct as that of the non-primary sector, estimated equation with seasonal dummies was not desirable.

The share of labor (1-3), 31 per cent, was very close to the actual proportion of labor costs, approximately 30 per cent out of total value added in manufacturing sector.

The estimated annual average of the marginal physical productivity of capital in the manufacturing sector was 31.1 per cent and that of labor was 73,191 wons at 1965 constant prices. Thus, the annual average of the marginal productivity of capital at current prices was approximately 40 per cent. This figure seems very reasonable considering both the bank and market rates of interest over the corresponding period.[7] The figure for marginal labor productivity is also acceptable, comparing with the average annual earnings per head in manufacturing sector, 66,700 wons at 1965 constant prices.

2. Consumption Equations

Only one aggregate private consumption function was considered in this paper, due to the lack of appropriate quarterly information for disaggregated consumption expenditures. While assuming consumption was dependent on lagged incomes, some qualifications were introduced. Income was adjusted for taxes. Money supply (or stock of money) was treated as a particular wealth variable, which may influence consumers' spending behaviour.[8]

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[7] The average bank rate of interest on major loans over the sample period was higher than 20 per cent before some additional costs, and was not lower than 40 per cent on private loans.

[8] For the influence of wealth variable on consumption expenditures, see following references: Ackley [1, pp. 273-279]; Klein [15, pp. 19-20]; Zellner [25, pp. 552-67]; Zellner, et. al. [26, pp. 571-581].

The coefficients on lagged disposable income were significant ranging back four quarters. There was no significant relation between current consumption and current income according to the estimated equations (2-1) and (2-2). It seems that a short-run lag effect exists due to psychological and institutional reasons.[9] First quarter lagged income had more influence on consumption than second and third quarter lagged incomes. The magnitude of fourth quarter lagged income coefficient was the largest among the four lags. The reason may be that the fourth quarter lag coefficient explains the affects of spending habits in the previous year and the seasonality of spending. According to equation (2-1), the imputed MPC with respect to disposable income was approximately 0.96, which was very close to the actual values of MPC over the sample period, 0.97.

The money supply variable was weighted by the Almon polynomial distributed lag technique.[10] When the money variable was taken into account, the equation was statistically improved, particularly in DW value (2-2).

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[9] Ackley [1, pp. 255-257].

[10] See footnote 12.

3. Investment Equations

A version of the flexible accelerator originated by Chenery and Koyck[11] was adopted. The determinants of investment included changes in output, the stock of money, and the availability of foreign capital. Since a large amount of investment goods are imported commodities, the availability of foreign capital has been one of the critical determinants of desired capital formation, especially in machinery and equipment. The stock of liquid assets represented by money supply is a particularly significant factor for construction investment, where capital cost is relatively greater than in other fields in regard to returns. It appears that the rate of investment is strongly constrained by the supply of fund (domestic and/or foreign sources), according to the estimated equations. The time structure of the investment process was taken into account by use of the Almon polynomial distributed lag structure.[12]

Five investment equations were considered as behavioural equations: (1) total fixed capital formation (I^f), (2) residential construction (I^h), (3) non-residential construction (I^{nh}), (4) investment in machinery and equipment (I^{meq}), and (5) inventory investment (I^i). In the actual forecasting process, government

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[11] Jorgenson [11].

[12] Almon [3] and Robinson [18].

construction (I^g) and other fixed capital investment (I^o) were exogenously estimated through the magnitudes of government investment and development loan and the total forecasted values of I^h, I^{nh}, and I^g (see appropriate equations on page 10).

The determinants of total capital formation were changes in the output of the non-primary sector,[13] money supply, and gross long-term foreign capital inflow. The seasonal variable for the first quarter was also included in order to take into account the slowdown in construction in wintertime.. During the sample period, more than 21 per cent of GNP was spent for fixed capital formation, of which more than 40 per cent was financed by foreign savings. Under the situation of imperfect capital market, the availability of domestic fund has also played a decisive role in the process of capital formation in Korea.

Residential building construction was assumed to depend positively on income and negatively on the housing stock - that is, at higher incomes, more is spent for housing, and the larger the housing stocks at any given level of income, the less is allocated to shelter. The Eisner type of permanent income theory for investment was also adopted in equation (3-3) using changes in income and money supply. The lagged value of residential building investment was included to take into account the effects of changes in income and of money supply lagged more than three periods. The seasonal factor was also included in both equations.

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[13]Primary sector production was excluded because of strong seasonality.

The most acceptable specifications of investment expenditures in non-residential buildings were obtained through the Eisner type of model. This included changes in the outputs of the non-primary sector, the level of money supply, and the dummy variable for winter. The lagged value of investment expenditures was included in order to represent the effects of changes in the outputs of the non-primary sector and in the money supply more than three periods back.

Investment in machinery and equipment was dependent upon changes in either non-primary output or output of the manufacturing sector and the inflow of long-term foreign loans. The foreign capital inflow was such a dominant determinant in this category of investment that the relative role of the accelerator version was markedly diminished as compared with other categories of investment. A shorter time structure for the investment process than the Almon distributed lag structure (refer p. 7) was thus as good as, or better than, the latter from a statistical point of view.

It was assumed that the larger the outputs, the more additional inventory was accumulated.

4. Import Equations

Total imports are disaggregated into (1) machinery and equipment, (2) intermediate materials (total commodity imports minus imports of machinery and equipment and grain), (3) grain, and (4) service including factor income. Imports of grain and service are treated as exogenous variables.

Imports of machinery and equipment were strongly related to long-term foreign loans and the ratio of effective import prices to domestic wholesale prices. As mentioned earlier, machinery and equipment imports have been highly constrained by foreign loans. In 1970, for example, nearly 50 per cent of total imports of machinery and equipment was financed by foreign loans.

Imports of intermediate materials were related to output in the manufacturing sector and the ratio of effective import prices to wholesale price indexes.

5. Price Equation

In order to explain and forecast the wholesale price level or rate of inflation in Korea, an attempt was made to develop a Harberger type of the dynamic model of inflation.[14]

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[14] Harberger [8, pp. 219-250].

The rate of price changes was taken as the dependent variable to be explained. It would not be advisable to take the level of price as the variable to be explained, because of the strong upward trends in the variables under consideration. The rate of inflation itself is an important policy variable, and policy makers often prefer to use the rate of price rises instead of the change in the price level.

From the short-run point of view, in addition to the changes in money supply and income, three more "autonomous" determinants of inflation were taken into account, namely, foreign exchange rates, public utility prices, and prices of rice. These three variables can be treated as "autonomous," because the changes in these variables are very strongly dependent upon policy decisions, at least over the short-term period, say less than a couple of years. The quantity theory of money tells us that price changes can be explained by the changes in the money supply and in the availability of goods and services, within a given system of institutions. Indeed, this theory is accepted in explaining a long-term inflation.

A detailed examination was made to inquire into the dynamic paths of increase in money supply, income, and foreign exchange rates in order to take into account their full effect upon the level of prices. The effects of other factors, e.g., wages and expectations, were also analyzed thoroughly. Although the price of rice and the public utility prices are not functionally related to prices but are components of the price level, it would

be still reasonable to take them as independent variables, because their changes have been observed to be "autonomous" in regard to the short-run price rise.

The result found for the wholesale price index using quarterly data is summarized in equation (5-1). The explanatory power of this equation is excellent and the result appears reasonable. Equation (5-1) suggests that it takes about a full year for an increase in the money supply to have its full influence on the wholesale price index,[15] and something like two and three quarters for the exchange rate and income, respectively.

The coefficient of changes in incomes (both current and lagged) is about a quarter (= 0.165 x 1.36),[16] indicating that a 10 per cent rise in real income, other things being equal, causes a fall of about 2.5 per cent in the price level. The coefficient of the lagged changes in money supply is about a quarter, indicating that a 10 per cent increase in the quantity of money causes a rise of 2.5 per cent in the price level, other things being equal.

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[15] Harberger suggested about two years for an increase in the money supply in his study of "Dynamic of Inflation in Chile."

[16] During the sample period, the growth rate of non-primary production was about 36 per cent higher than that of income as a whole.

More than about 35 per cent of the total weight of the wholesale price index is accounted for by internationally traded goods. Hence a 10 per cent devaluation, for example, would virtually automatically raise the price index by about 3.5 per cent. About 13 per cent of the total weight of the wholesale price index is accounted for by public utility items and about five per cent by the indirect effect on production costs attributed to public utilities. It appears there is a tendency for the sellers to take the public utility price rise as a sort of signal of further inflation, and to raise their own prices. The weight of rice in wholesale price index is about 10 per cent, indicating that a 10 per cent increase in the price of rice would automatically raise the price index by about one per cent. Again the producers of other food items may increase their own prices when the price of rice increases.

The role of wage rates and expectations was assumed to be somewhat significant in determining prices, but we failed to prove that empirically. It seems the wage rate in Korea is "led" by the general price rise, instead of the other way around, due to the existence of relatively "plentiful" labor supply. It seemed the role of expectation in the price rise in Korea was prominent, but it was difficult to explain it empirically.

The absolute sizes of the coefficients of both the changes in income and stock of money, about a quarter, are much smaller than the magnitude one may normally expect. However, the magnitudes of the coefficients found in the equation (5-1) appear very

reasonable. Since approximately 70 per cent of the total weight of the wholesale price index was accounted for by the commodities related to the above three variables (exchange rates, public utility prices, prices of rice), slightly more than a quarter of total changes in prices was left to be explained by the increase in aggregate income.

Over the period 1964 to 1971, the money supply increased at an annual rate of about 30 per cent, out of which about 11 per cent (= 5.6 + 3.0 + 1.9)[17] was believed to be associated with the increased exchange rates, public utility prices, and prices of rice. Assuming the real outputs of commodities related to the above three variables, which amounts to about 70 per cent of the total income, increased at the same annual rate as income (about 13 per cent), approximately another 10 per cent (13 x 0.70) of the money supply was believed to be associated with the increased production. Thus, the remaining nine per cent of the average annual growth of the money supply, which was slightly more than a quarter of the increase in the money supply (30 x 0.25), was left to be associated with the changes in prices of the rest of commodities.

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[17] See Table 1.

Table 1: Magnitudes of coefficients and average annual growth rates of price variables, 1964—1971.

Name of variable	Coefficient	Average annual rate of increase (per cent)	Average annual wholesale price increase associated with the variables (per cent)
	(1)	(2)	(3) = (1) x (2)
Exchange rate	.363	15.5	5.6
Public utility price	.200	15.0	3.0
Price of rice	.121	15.3	1.9
Total	-	-	10.5

IV. SOME APPLICATIONS

In the trial calculations using the present model, (1) two types of ex post tests were experimented with and (2) ex ante forecasts were also computed for the years 1972 and 1973.

1. Ex Post Test of the Model

Ex post forecasting has the advantage of testing the forecasting ability of the model. Since good estimates of the predetermined exogenous variables are available, one can avoid errors in the assumptions for the exogenous variables.

The first type of test provides interpolation from 1968 to 1971 by two-year interval (which is called the "final test"). Predetermined variables were inserted into the first quarter of 1968 (and the first quarter of 1970). The system was then recursively solved with iterations as a dynamic model through the fourth quarter of 1969 (and the fourth quarter of 1971). Exogenous variables were assigned their actual values for each quarter's solution, but lagged endogenous variables were generated within the model after starting from given initial conditions. GNP imputed from the demand side was equated with total outputs generated from production functions by treating the differences as a category of inventory and statistical discrepancy. The results of this simulation experiment are given in Table 2 and Figures 1-6 in the Appendix.

Table 2: Actual and Simulated Values of Selected Variables, 1968—1971 (ex post interpolation of internal sample data).

billions of 1965 wons

Year & Quarter		V^{na}		V^{m}		I^{f}	
		Actual	Computed	Actual	Computed	Actual	Computed
1968	I	163.33	167.91	54.25	55.88	51.83	59.73
	II	200.08	200.38	65.30	65.60	80.67	78.00
	III	207.64	204.17	69.55	70.27	83.22	80.66
	IV	224.96	223.32	73.91	76.13	107.26	93.34
1969	I	194.87	190.58	68.43	66.69	65.14	72.17
	II	227.91	226.53	77.74	78.28	105.50	103.54
	III	242.70	240.64	82.80	86.30	113.66	108.85
	IV	270.35	269.50	92.59	93.50	123.46	114.03
1970	I	218.28	222.02	78.83	79.33	75.21	76.54
	II	265.57	267.00	94.23	93.13	107.78	104.44
	III	273.29	274.15	97.72	101.23	106.03	101.41
	IV	297.82	299.87	108.49	110.96	127.74	131.01
1971	I	252.64	254.80	98.79	93.28	78.46	75.10
	II	307.83	306.44	115.90	109.50	115.06	105.69
	III	302.66	296.82	116.86	112.60	106.08	115.86
	IV	327.33	324.67	120.13	121.98	138.94	138.11

Table 2: Continued

Year & Quarter		I^h Actual	I^h Computed	Mc Actual	Mc Computed	P' Actual	P' Computed
1968	I	3.02	3.18	73.70	78.83	3.32	2.86
	II	8.07	7.26	88.64	86.03	1.66	1.74
	III	8.63	6.87	87.87	83.68	0.58	0.69
	IV	8.55	7.23	101.01	94.31	1.98	2.53
1969	I	2.73	4.91	88.98	82.16	2.28	2.41
	II	8.25	9.47	111.23	109.10	1.67	1.76
	III	8.07	8.40	117.28	140.14	0.88	1.15
	IV	8.56	8.03	120.41	127.51	1.63	2.32
1970	I	3.39	5.60	102.50	106.98	4.28	4.06
	II	14.19	11.13	113.01	105.79	2.36	2.57
	III	10.99	10.72	122.61	118.24	0.70	0.73
	IV	8.85	9.89	140.72	158.89	1.59	2.09
1971	I	5.27	5.92	123.68	114.04	1.76	1.50
	II	12.28	11.93	160.17	142.95	2.21	1.87
	III	10.35	9.21	155.05	148.57	2.82	2.74
	IV		10.51	142.31	146.56	5.49	5.[illegible]

The second type of test provides extrapolation beyond the terminal sample data, IV-1969, for the years 1970 and 1971. A new set of equations based on sample data, I-1962---Iv-1969, was estimated (see Table 1 in Appendix). Ex post extrapolations of a model outside the sample data provide better tests than do ex post calculations using internal sample data.[18]

The system was again recursively solved by the same ways as for the first type of the test. Again the exogenous variables were assigned their actual values for each quarter's solution, and the lagged endogenous variables were estimated within the system. The ex post extrapolations were in most cases as good as the ex post interpolations in terms of forecasting ability. The results are shown in Table 3 and Figure 1-12 in Appendix.

While the quarterly estimates of V^{na}, V^{m}, I^{f}, I^{h}, and P' were very close to the actual values, the estimates of M^{c} were not as close as the others. The imputed annual forecasts from the quarterly forecasts of M^{c} were, however, fairly close to the actual values. It seems that M^{c} is very sensitive to trade policy adjustments.

The annual average growth rates of the estimated GNP were also calculated and compared with actual growth rates. The results are shown in Figures 3 and 4. The forecasts hit the turning points (peak and trough) surprisingly well. The model predicted the 1969 peak and 1970 trough with very little underestimate of the peak and

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[18] Klein [15- p. 3

Table 3: Actual and Simulated Values of Selected Variables, 1970—1971 (ex post extrapolation outside the sample data).

billions of 1965 wons

Year & Quarter		V^{na}		V^{m}		I^{f}	
		Actual	Computed	Actual	Computed	Actual	Computed
1970	I	218.28	227.13	78.83	87.49	75.21	76.54
	II	265.57	260.32	94.23	93.38	107.78	104.44
	III	273.29	275.06	97.72	99.89	106.03	104.23
	IV	297.82	292.69	108.49	107.73	127.74	140.42
1971	I	252.64	254.28	98.79	103.44	78.46	74.38
	II	307.83	313.68	115.90	108.76	115.06	102.92
	III	302.66	302.69	116.86	116.73	106.08	117.34
	IV	327.33	322.36	120.13	115.84	138.94	150.04

Year & Quarter		I^{h}		M^{c}		P'	
		Actual	Computed	Actual	Computed	Actual	Computed
1970	I	3.39	6.47	102.50	111.48	4.28	3.97
	II	14.19	10.57	113.01	104.50	2.36	2.47
	III	10.99	10.73	122.61	116.03	0.70	0.78
	IV	8.85	11.28	140.72	155.44	1.59	2.35
1971	I	5.27	7.36	123.68	120.03	1.76	1.57
	II	12.28	11.18	160.17	140.93	2.21	1.92
	III	10.35	10.93	155.15	150.76	2.82	2.90
	IV		11.69	142.31	140.66	5.49	6.01

overestimate of the trough. The extrapolation was even able to predict one of the deepest troughs after the economy achieved the highest peak in our history in 1969.

2. Ex Ante Forecasts

For the predictions of the 1972 and 1973, the model was extrapolated beyond the terminal sample data, IV-1971. These predictions were completed in March, 1972 and presented to the Economic Planning Board as a guide in reviewing and formulating the Overall Resources Budget (Korean annual plan) of 1972 and 1973.[19]

The system was recursively solved by the same procedures as for the ex post forecasts. Table 4 shows values of the predetermined exogenous variables used in 1972 forecasts. The results are shown in Table 5 and Figures 1-6 in the Appendix. Estimates of the annual rate of growth of GNP calculated from the quarterly forecasts are also shown in Figure 3. According to the model forecasts, the annual rate of GNP growth in 1972 is expected to be down to about eight per cent, the lowest growth rate since 1966. In 1973, however, the economy is predicted to recover from the expected trough of 1972, achieving annual growth rate of about nine per cent.

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[19] Korea Development Institute [16].

Figure 3: Actual and Simulated Increasing Rates of V, 1968—1971 (ex post interpolation of internal sample data), and Forecasted Rates, 1972—1973.

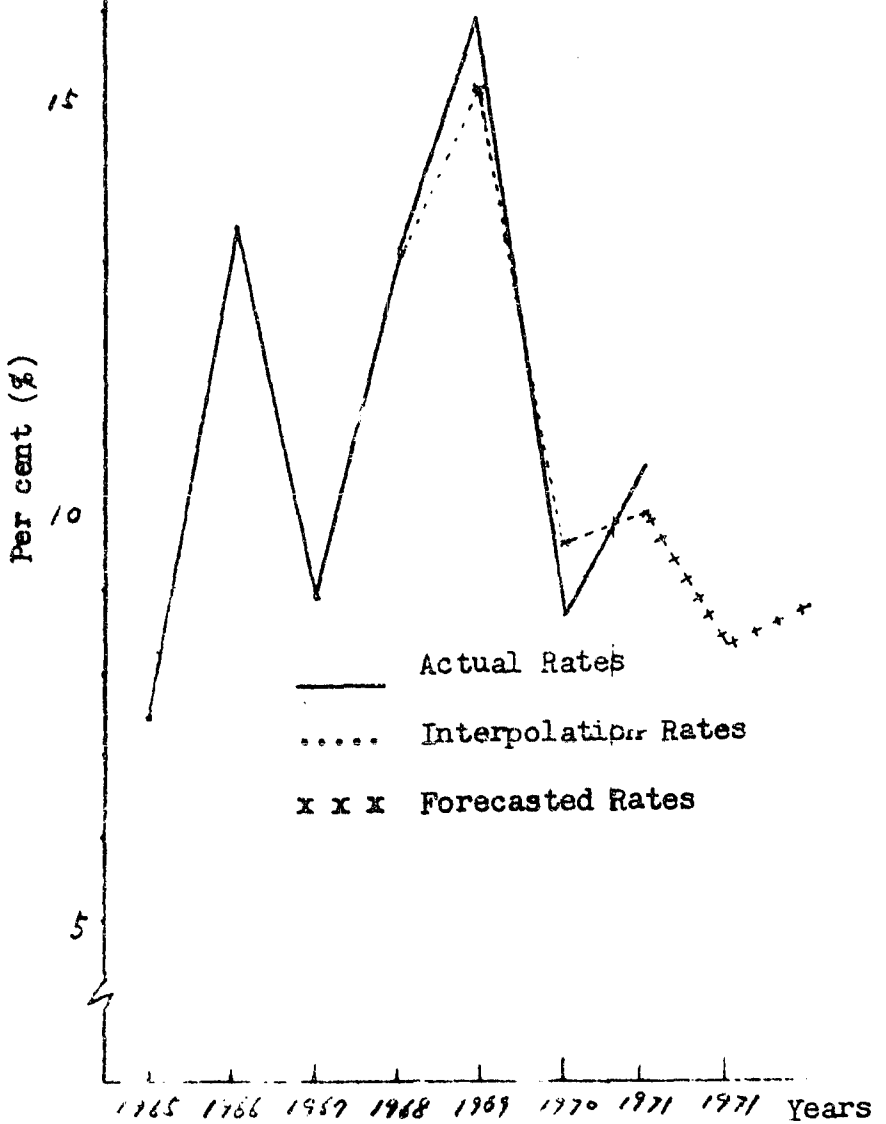


Figure 4: Actual and Simulated Increasing Rates of V, 1970—1971 (ex post extrapolation outside sample data)

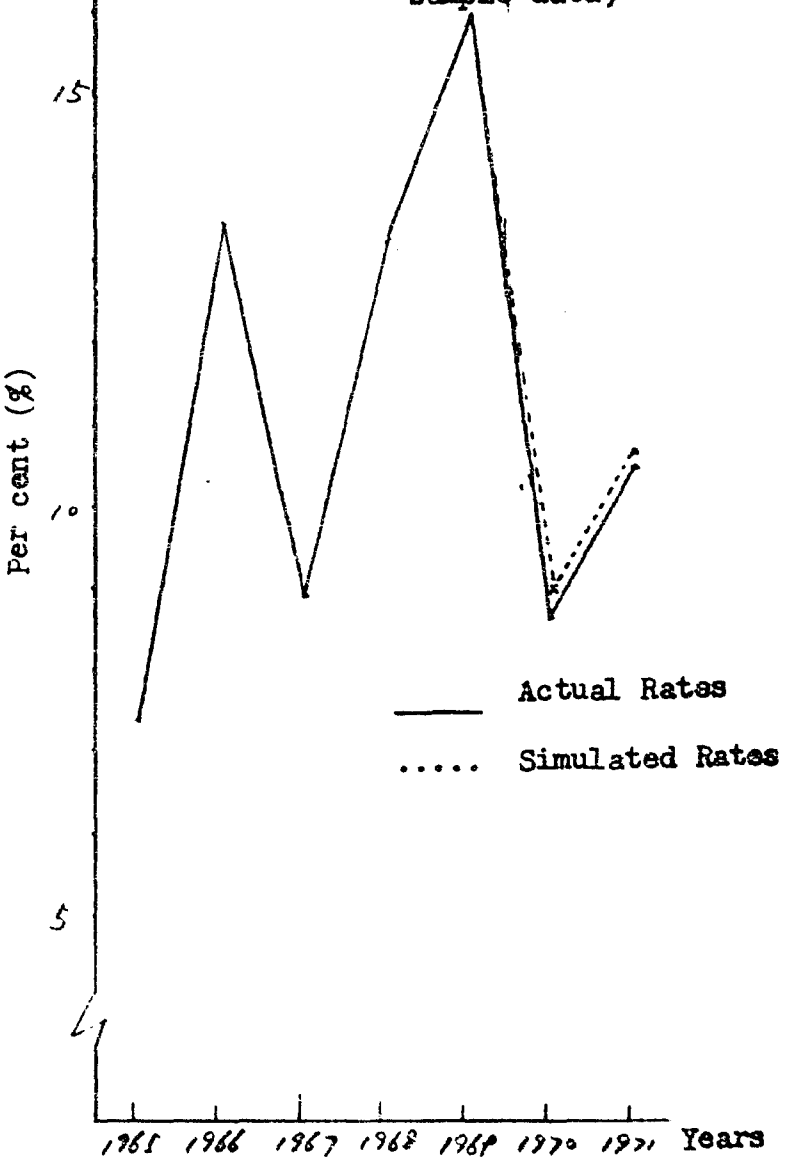


Table 4: Predetermined Exogenous Variables Used in the Forecasts, 1972—1973

		MSN	MS	R^m	P^{rm}	FL
Units		billions of current wons	billions of 1965 wons	won/ /dollar	won/ /dollar	billions of 1965 wons
1972	I	360.36	200.94	382.75	240.91	43.93
	II	366.96	210.64	397.56	239.61	49.82
	III	385.67	213.77	410.34	270.24	57.62
	IV	421.11	226.42	417.12	267.68	52.39
1973	I	425.26	227.97	426.13	262.22	47.62
	II	433.04	227.56	443.60	257.32	54.00
	III	455.13	233.34	457.84	249.84	62.46
	IV	496.95	250.45	465.39	247.85	56.79

		E	E^c	G^i	C^g
Units		billions of 1965 wons	billions of 1965 wons	billions of 1965 wons	billions of 1965 wons
1972	I	99.87	76.44	15.40	32.52
	II	123.46	94.49	23.65	36.25
	III	139.13	106.49	29.15	38.77
	IV	135.20	103.48	41.80	45.11
1973	I	120.86	96.78	17.25	34.91
	II	149.40	119.63	26.49	39.15
	III	168.37	134.82	32.65	41.87
	IV	163.62	131.01	46.82	48.72

Table 4: Continued

		M^g	M^s	L^{na}	L^m	V^a
Units		billions of 1965 wons	billions of 1965 wons	million persons	thousand persons	billions of 1965 wons
1972	I	10.26	27.19	5.11	1256	24.29
	II	13.87	37.82	4.66	1140	62.65
	III	20.56	39.67	5.23	1318	34.13
	IV	26.82	42.36	5.60	1437	272.32
1973	I	7.32	34.53	5.26	1310	25.26
	II	9.90	40.38	4.80	1164	65.16
	III	15.56	43.21	5.39	1323	35.50
	IV	20.31	45.37	5.77	1456	283.21

		T	p^r	p^u	t
Units		billions of 1965 wons	1965=100	1965=100	
1972	I	52.28	162.86	116.89	49
	II	73.64	164.49	118.77	50
	III	73.15	166.20	119.87	51
	IV	87.86	171.32	124.76	52
1973	I	56.16	181.82	128.71	53
	II	79.06	186.03	132.76	54
	III	77.77	188.02	135.32	55
	IV	93.56	208.74	140.84	56

Table 5: Selected Forecast Values, 1972—1973

billions of 1965 wons

Year & Quarter		V^{na}	V^{m}	I^{f}	I^{h}	M^{c}	P'
1972	I	276.09	108.41	85.32	6.30	129.33	2.97
	II	331.74	117.65	121.48	12.16	141.56	1.70
	III	335.08	131.20	115.41	9.62	166.12	1.45
	IV	363.86	140.02	137.24	8.90	174.32	1.89
1973	I	304.46	126.52	86.40	4.71	142.28	1.96
	II	362.32	129.70	131.03	12.18	151.29	2.07
	III	367.91	146.57	125.24	10.32	175.76	1.86
	IV	402.42	158.01	152.68	9.41	184.01	3.18

V. CONCLUDING REMARK

The present paper is a progress report and will be only one contribution to a series of Korean macro-models. The ancestors of this model have been used to make a number of annual forecasts, providing helpful tools in formulating the national economic plans. Since it was our first experience in building a quarterly model of the Korean economy, it will set the stage for more work and further improvement to come.

The limitation of our quarterly data is one of the most serious problems in developing short-term forecasting models. As the short-term model develops, a systematic collection of quarterly time series data will be highly valuable. At least two more production functions, for social overhead and service industries, can be separately estimated when the data on capital stock are available. Inventory might have to be subdivided into agricultural and non-agricultural groups, and imported raw materials and other imports. Consumption expenditures might also be needed to disaggregate into durable, non-durable, and service consumption expenditures.

The exogenously estimated values of government investment and other investments (construction in electricity and private non-building construction) are especially unsatisfactory and we need to develop better ways to estimate those values. Prediction of the inflow of long-term foreign loans is also very difficult, yet it is a very significant determinant of fixed capital

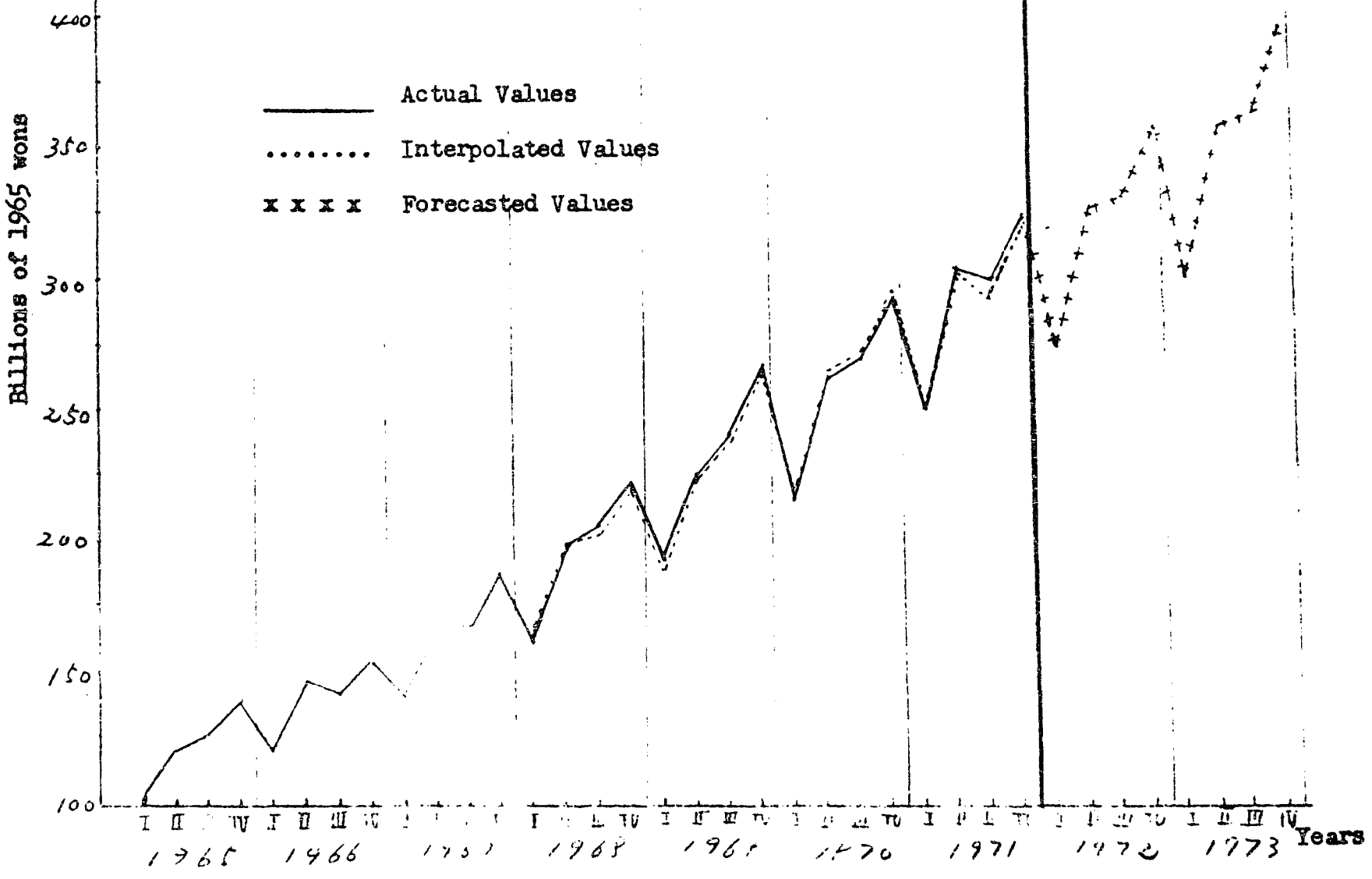
formation and machinery imports. The inflow of long-term foreign loans depends largely upon government policy dicisions and international economic and political conditions.

It would be desirable to introduce some relations between the quantity of money supplied and the effective demand for money, since the role of monetary policy is very important in economic fluctuations, growth, and stabilization. The role of cash balances is so prominent in the processes of production, investment, and consumption. The exogenous treatment of the government sector (government consumption, investments and loan, and tax revenues), is not desirable. It will be sensible to distinguish between induced government expenditures and autonomous categories. Then some equations also can be developed for the induced part of the expenditures. It will also be possible to introduce some tax equations into the model. Chong Kee Park and Wan-Sun Kim at KDI have recently developed a number of projection equations for tax revenues.

All these improvements require substantial research work, but they are all feasible and can be added to the basic system presented here.

APPENDIX

Figure 1: Actual and Simulated Values of $V^{i,a}$, 1968—1971 (ex post interpolation of internal sample data), and Forecasted Values, 1972—1973 (ex post quarterly extrapolation outside sample data)



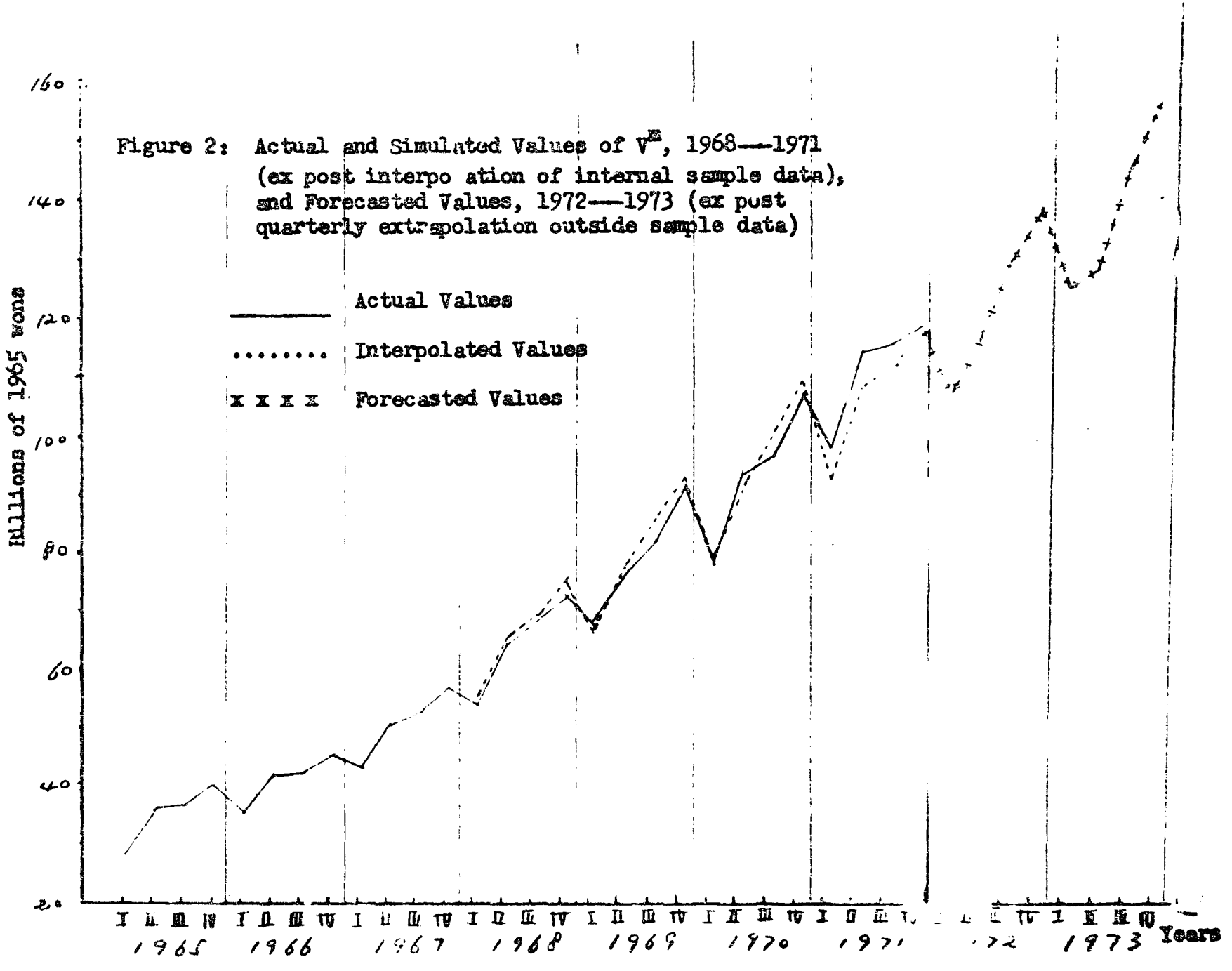


Figure 2: Actual and Simulated Values of V^{m}, 1968—1971 (ex post interpo ation of internal sample data), and Forecasted Values, 1972—1973 (ex post quarterly extrapolation outside sample data)
Actual Values
Interpolated Values
Forecasted Values
Millions of 1965 wons
160
140
120
100
80
60
40
20
I II III IV
1965
1966
1967
1968
1969
1970
1971
1972
1973
Years

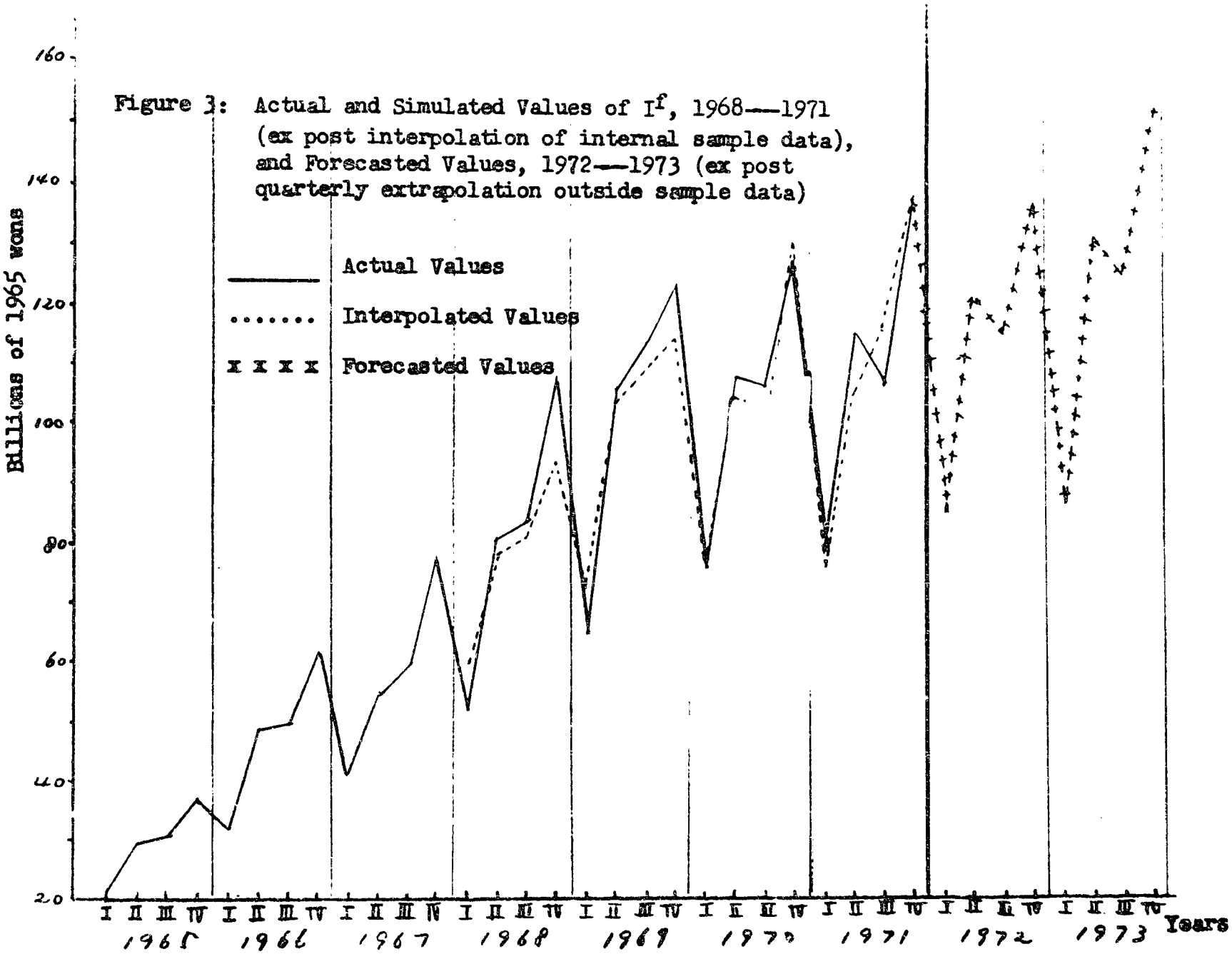


Figure 3: Actual and Simulated Values of I^f, 1968—1971 (ex post interpolation of internal sample data), and Forecasted Values, 1972—1973 (ex post quarterly extrapolation outside sample data)

Figure 4: Actual and Simulated Values of I^h, 1968—1971 (ex post interpolation of internal sample data), and Forecasted Values, 1972—1973 (ex post quarterly extrapolation outside sample data)

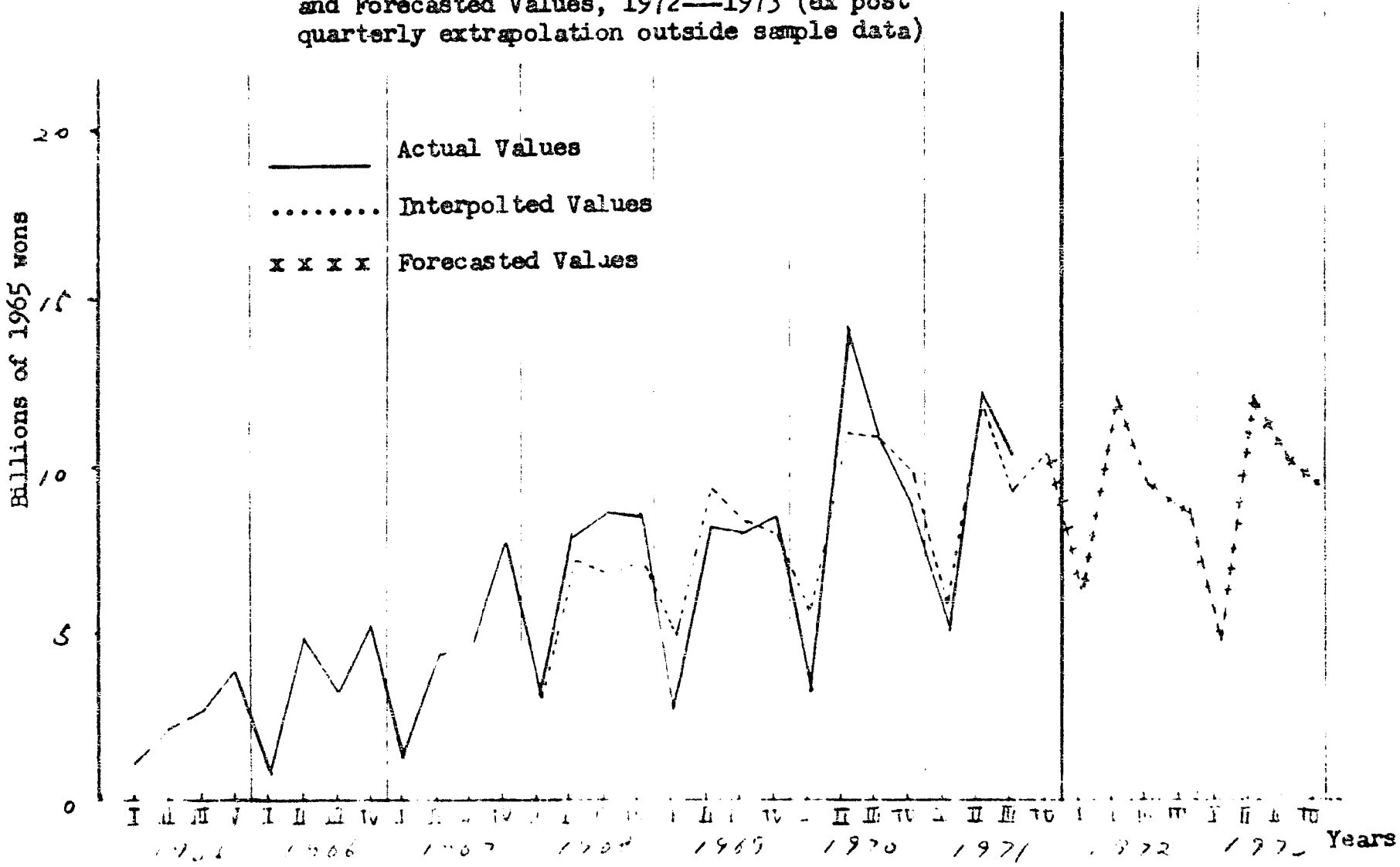
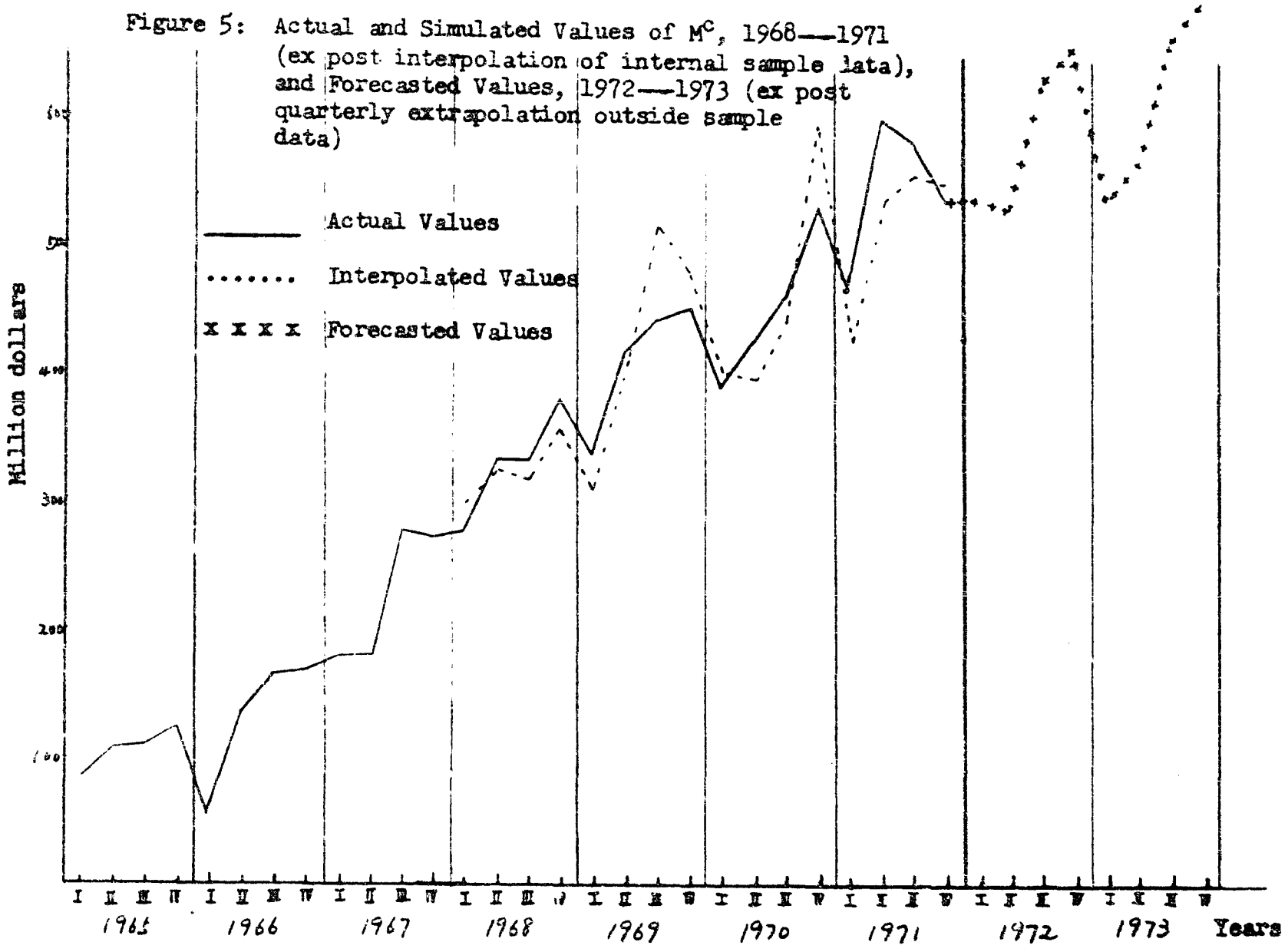


Figure 5: Actual and Simulated Values of M^c, 1968—1971 (ex post interpolation of internal sample data), and Forecasted Values, 1972—1973 (ex post quarterly extrapolation outside sample data)



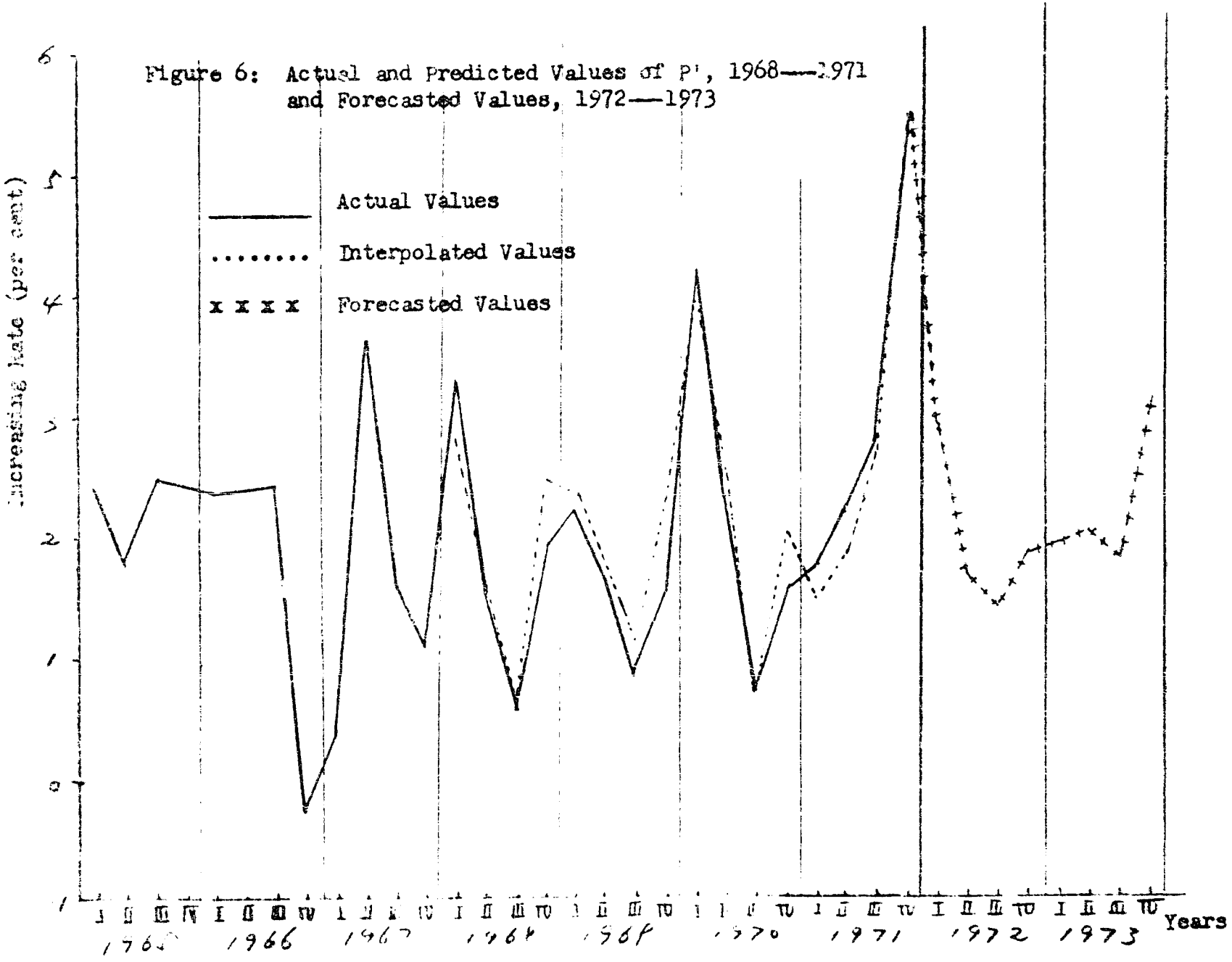


Figure 6: Actual and Predicted Values of P', 1968—1971 and Forecasted Values, 1972—1973

Figure 7: Actual and Simulated Values of V^{na}, 1970—1971
(ex post quarterly extrapolation outside sample data)

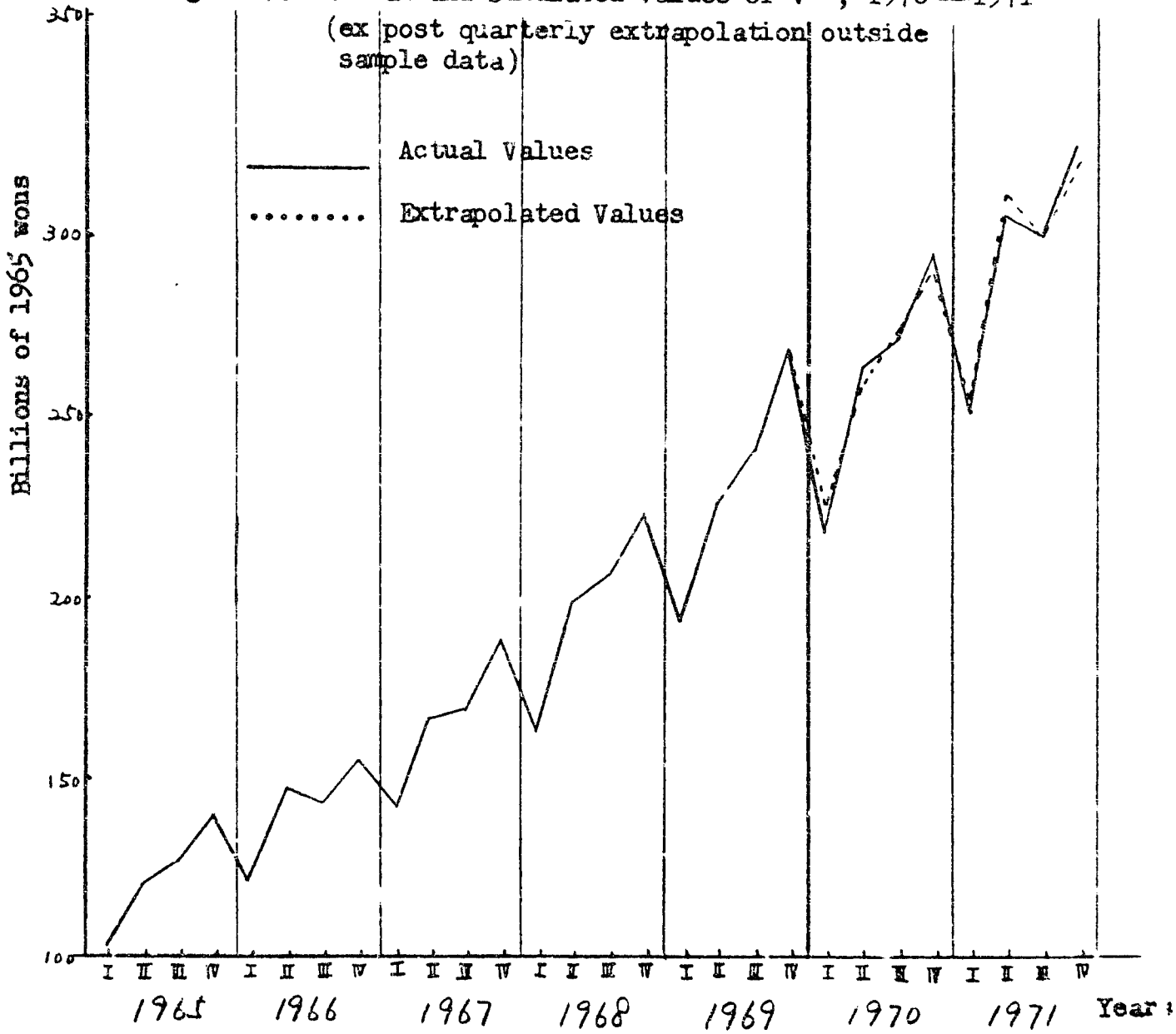


Figure 8: Actual and Simulated Values of V^m, 1970—1971 (ex post quarterly extrapolation outside sample data)

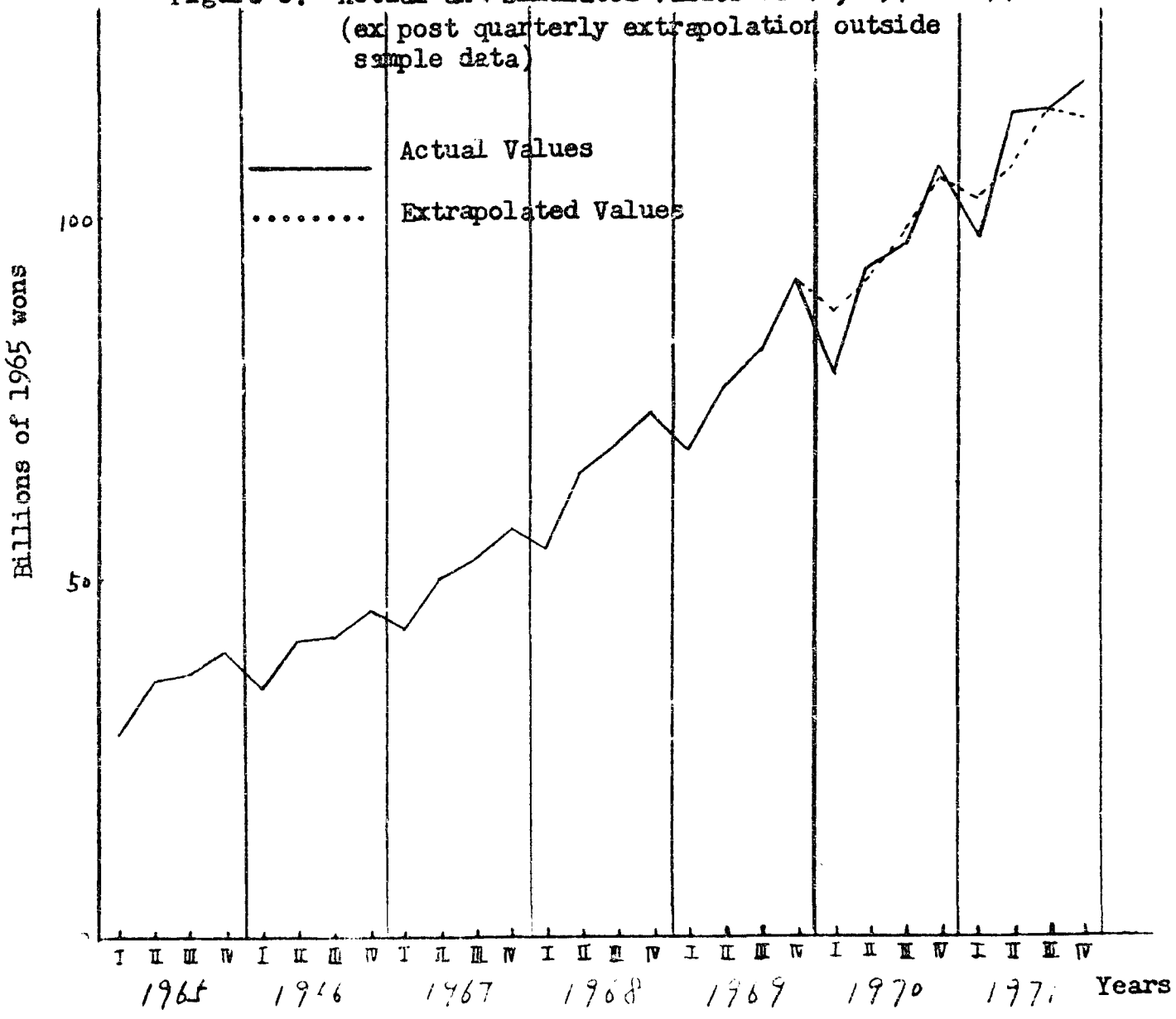


Figure 9: Actual and Simulated Values of I^f, 1970—1971 (ex post quarterly extrapolation outside sample data)

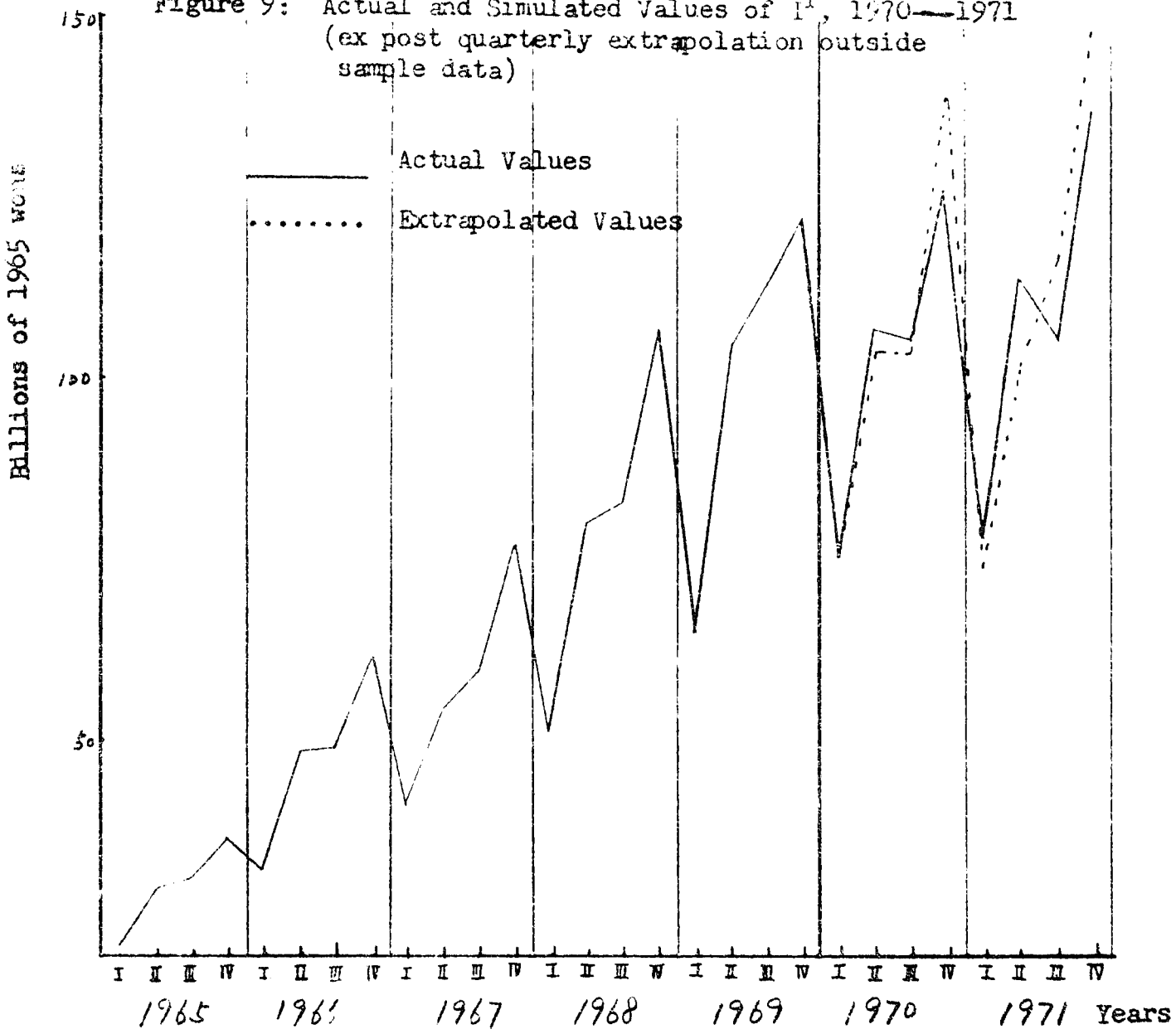
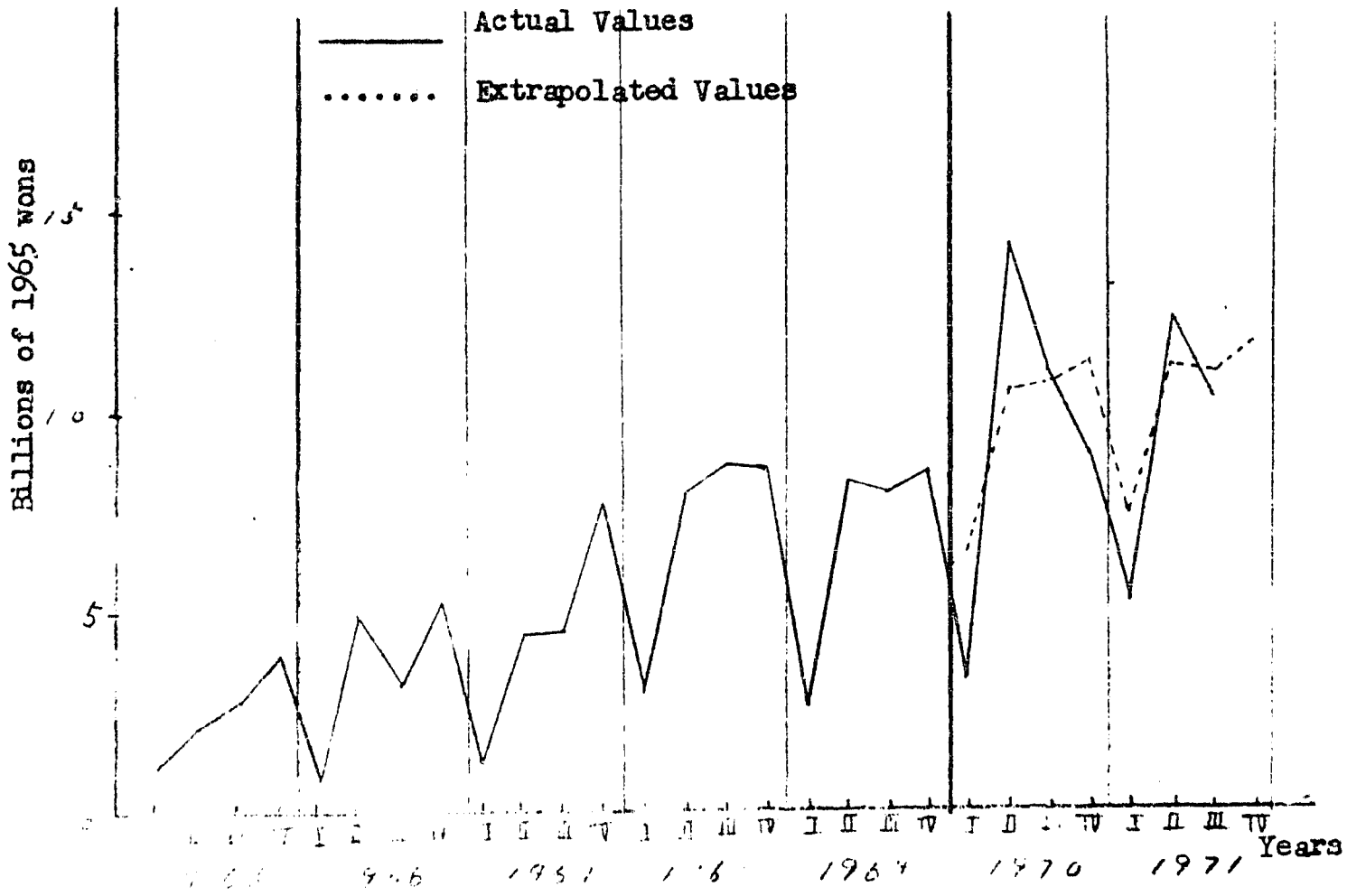


Figure 10: Actual and Simulated Values of I^h, 1970—1971 (ex post quarterly extrapolation outside sample data)



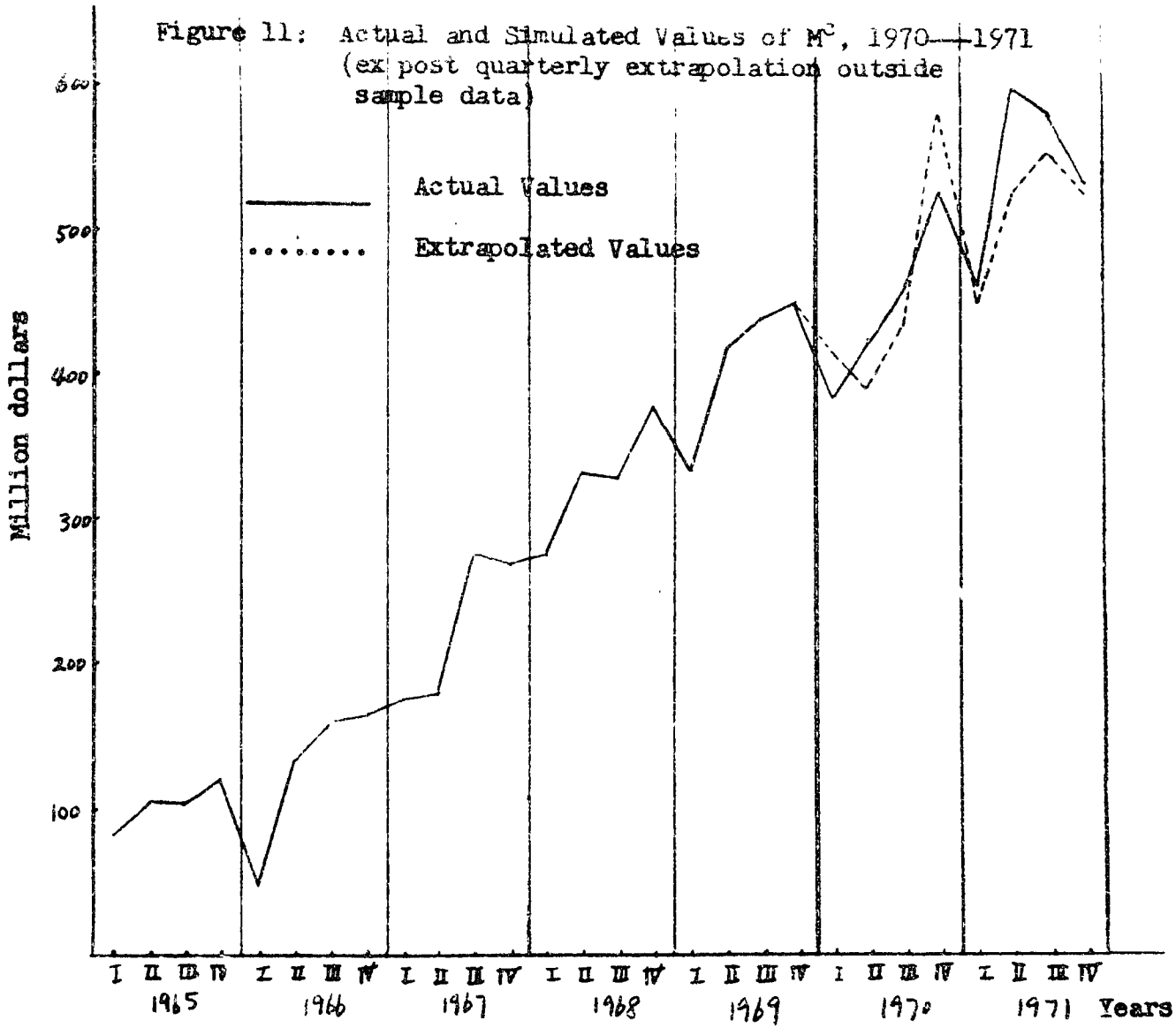


Figure 11: Actual and Simulated Values of M^c, 1970—1971 (ex post quarterly extrapolation outside sample data)

Figure 12: Actual and Simulated Values of P', 1970—1971
(outside sample data)

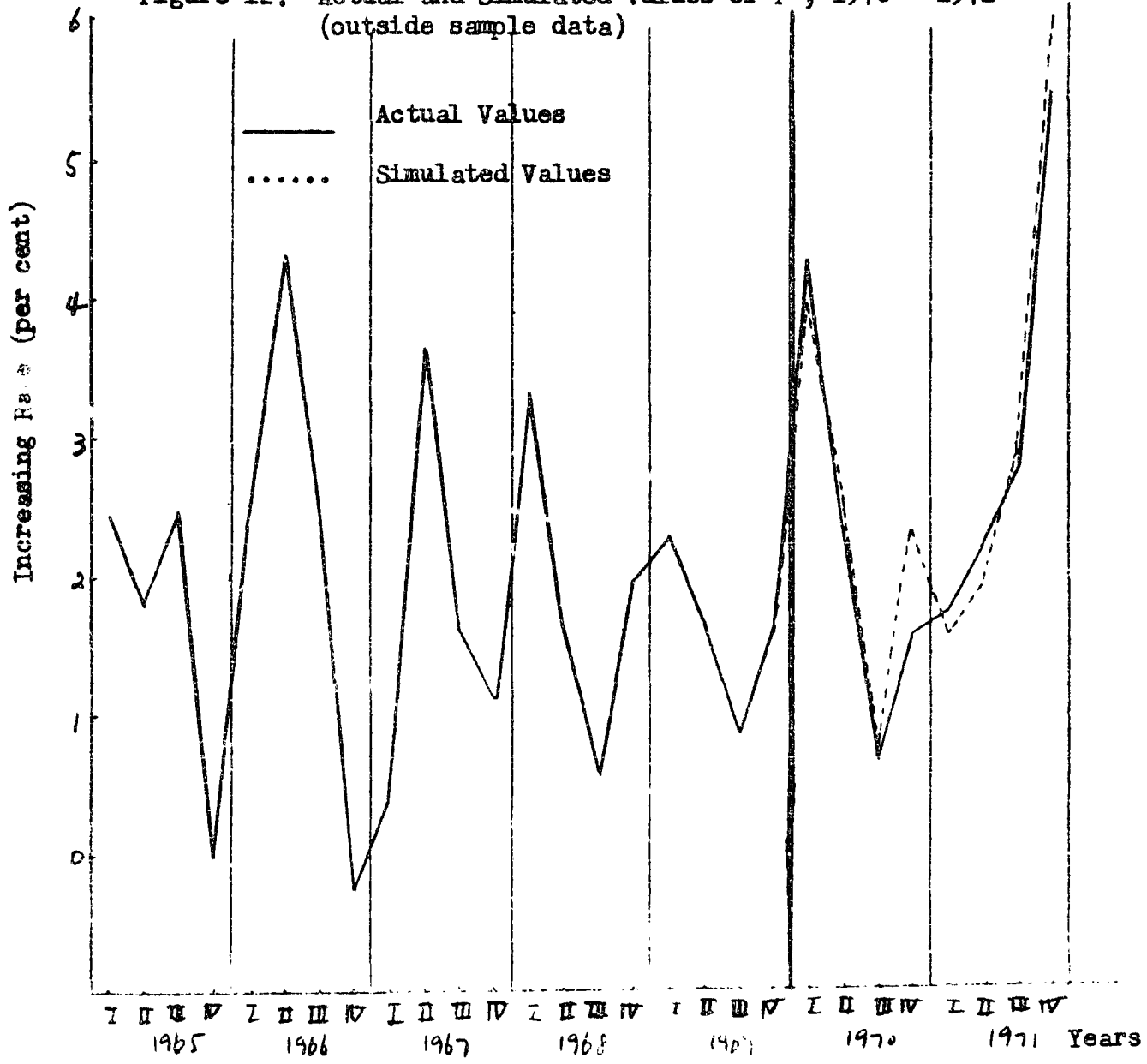


Table 1: Estimated Structural Equations (Based on Sample Data up to IV-1969)

$$\log\left(\frac{V^{na}}{L^{na}}\right) = \underset{(0.868)}{-0.186} + \underset{(0.129)}{0.386} \log\left(\frac{K^{na}_{-1}}{L^{na}}\right) + \underset{(0.063)}{0.140} \log\left(\frac{M^{i}}{L^{na}}\right)$$

$$+ \underset{(0.082)}{0.121} \log\left(\frac{MS^{i}}{L^{na}}\right) + \underset{(0.003)}{0.013}\, t + \underset{(0.021)}{0.117}\, D2$$

$R^2 = 0.946$ $\quad DW = 2.27$

Sample period = III-1963—IV-1964

$$\log\left(\frac{V^{m}}{L^{m}}\right) = \underset{(0.309)}{-0.714} + \underset{(0.112)}{0.359} \log\left(\frac{K^{m}_{-1}}{L^{m}}\right) + \underset{(0.067)}{0.350} \log\left(\frac{MS^{i}}{L^{m}}\right)$$

$$+ \underset{(0.003)}{0.018}\, t + \underset{(0.029)}{0.146}\, D2$$

$R^2 = 0.900$ $\quad DW = 2.45$

Sample period = I-1963—IV-1969

$$C^{p} = \underset{(7.031)}{19.410} + \underset{(0.019)}{0.216}\, V^{d}_{-1} + \underset{(0.019)}{0.111}\, V^{d}_{-2} + \underset{(0.019)}{0.111}\, V^{d}_{-3} + \underset{(0.021)}{0.306}\, V^{d}_{-4}$$

$$+ \underset{(0.078)}{0.250}\, MS^{c}$$

$R^2 = 0.971$ $\quad DW = 2.0$

Sample period = I-1961—IV-1969

Table 1: Continued

$$I^{h} = \underset{(61.548)}{91.620} + \underset{(0.045)}{0.128}\, V^{na^{i}} - \underset{(0.054)}{0.083}\, St^{h}_{-1} - \underset{(0.501)}{1.363}\, D1 + \underset{(0.430)}{0.937}\, D4$$

$R^2 = 0.877$ DW = 1.98

Sample period = II-1961—IV-1969

where $V^{na^{i}} = 0.452\, V^{na}_{-4} + 0.352\, V^{na}_{-3} + 0.196\, V^{na}_{-2}$

$$I^{nh} = \underset{(0.872)}{1.688} + \underset{(0.028)}{0.062}\,\Delta V^{na}_{-2} + \underset{(0.036)}{0.090}\,\Delta V^{na}_{-3} + \underset{(0.037)}{0.121}\,\Delta V^{na}_{-4}$$

$$+ \underset{(0.017)}{0.011}\, MS^{nh} + \underset{(0.113)}{0.583}\, I^{nh}_{-1} - \underset{(0.017)}{2.165}\, D1$$

$R^2 = 0.832$ DW = 2.15

Sample period = III-1961—IV-1969

$$I^{g} = \underset{(0.580)}{-1.330} + \underset{(0.056)}{1.077}\, G^{i} + \underset{(0.837)}{2.333}\, D4$$

$R^2 = 0.919$ DW = 1.88

Sample period = I-1960—IV-1969

$$I^{meq} = \underset{(1.135)}{7.674} + \underset{(0.102)}{0.256}\,\Delta V^{na}_{-2} + \underset{(0.129)}{0.122}\,\Delta V^{na}_{-3} + \underset{(0.142)}{0.266}\,\Delta V^{na}_{-4}$$

$$+ \underset{(0.129)}{0.273}\,\Delta V^{na}_{-5} + \underset{(0.091)}{0.713}\, FL$$

$R^2 = 0.930$ DW = 1.75

Sample period = IV-1961—IV-1969

Table 1: Continued

$$M^{i} = \underset{(5.334)}{8.103} + \underset{(0.041)}{0.837}\, V^{m} - \underset{(0.021)}{0.043}\, P^{rm}$$

$R^2 = 0.918$ DW = 1.96

Sample period = I-1960---IV-1969

$$M^{meq} = \underset{(3.676)}{10.675} + \underset{(0.038)}{0.831}\, FL - \underset{(0.015)}{0.027}\, P^{rm}$$

$R^2 = 0.931$ DW = 1.34

Sample period = I-1960—IV-1969

$$P' = \underset{(0.486)}{-0.485} - \underset{(0.088)}{0.162}\, wV^{na'} + \underset{(0.054)}{0.195}\, wMSN + \underset{(0.088)}{0.377}\, wR^{m'}$$

$$+ \underset{(0.012)}{0.127}\, P^{r'} + \underset{(0.026)}{0.209}\, P^{u'}$$

$R^2 = 0.924$ DW = 1.77

Sample period = I-1965—IV-1970

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Preliminary
Not to be quoted

THE BRUNO PRODUCTION FUNCTION, FACTOR MARKET DISEQUILIBRIUM, AND FACTOR CONTRIBUTIONS TO GROWTH IN THE KOREAN INDUSTRIAL SECTORS

Kyu Sik Lee

Working Paper 7208

Korea Development Institute

May 24, 1972

PREFACE

This paper is one in the series of continuing KDI research works which is designed to aid in the formulation of sound public policies and to promote public understanding of issues of the Korean economy.

This paper is part of a large project on sources of growth in the Korean economy, in which the author intends to identify and measure sources of past growth in the Korean economy, to make projections of future growth, and to provide policy alternatives regarding growth vs. other conflicting policy objectives.

The interpretations and conclusions in this paper are those of the author and do not represent the views of the Korea Development Institute. Finally, I would like to extend my appreciation to those within and outside of this Institute who have participated in these endeavours.

Mahn Je Kim
President

THE BRUNO PRODUCTION FUNCTION, FACTOR MARKET DISEQUILIBRIUM, AND FACTOR CONTRIBUTIONS TO GROWTH IN THE KOREAN INDUSTRIAL SECTORS*

by

Kyu Sik Lee

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I. INTRODUCTION

Most studies on sources of growth [3, 10, 12] have been in the Denison-Solow [4, 11] tradition, in which competitive equilibrium and the Cobb-Douglas form of production function are implicitly assumed. An exception to this approach is the interesting work by Bruno [2] for the Israel economy. Although the Bruno production function may be viewed as a simple modification of the Cobb-Douglas form, with the addition of disequilibrium side-condition it is very rich in theoretical content and empirically estimable. In a rapidly growing economy like Korea we can not assume competitive equilibrium in the factor markets. The Bruno model is particularly attractive in that we can measure the extent of disequilibrium in the factor markets in a developing country.

This paper reports only a small part of a large project on sources of growth in the Korean economy. Here we do not intend to go through the usual "residual analysis", which will be dealt with later. Our main concern in this paper will be to estimate the Bruno model in order to measure factor contribution to growth and productivity changes under structural disequilibrium. Although attempts are being made to test the model for eight industrial sectors, the nonagricultural sector, and the total economy, the results for only three sectors are reported here. Annual time-series data for 1957-1970 are used for the following three sectors: 1) manufacturing; 2) electricity, water and sanitary services; and 3) transportation, storage, and communication.

The theoretical properties of the Bruno model are briefly summarized in Section II, the empirical results are reported in Section III, and in the last section concluding remarks are made with some policy implications.

II. THEORETICAL PROPERTIES AND ECONOMIC IMPLICATIONS OF THE BRUNO MODEL

The Bruno model[1] consists of the following three equations.

(1) Production function[2]:

$$V = A e^{\lambda t} K^{\alpha} L^{1-\alpha} - mL,$$

where V = output, K = capital, L = labor, t = time, and $A > 0$, $0 < \alpha < 1$.

(2) Factor share equation:

$$V/L = c\,w + d,$$

where w = real wage, and $c > 0$.

(3) Wage equation:

$$\partial V/\partial L = p\,w + q,$$

where $p \neq 1$, and $q \neq 0$.

---

[1] For the detailed discussion on the properties of the model see Bruno [2, pp. 50-55].

[2] Constant returns to scale and exponential technical change are assumed.

The parameters are assumed to have the following relationships.

(4) $p = (1 - \alpha)\, c, \quad q = (1 - \alpha)\, d - \alpha m.$

The conditions of positive and diminishing marginal factor productivities require the following restrictions among parameters: if $m > 0$, then $0 < \alpha < 1$; if $m < 0$, then $-1 < m/y < 0$, and $0 < \alpha < 1$, where $y = V/L$.

Now we summarize the economic implications of the model.

1. <u>echnical Change</u>

The ratio of marginal productivities can be written as

$$(5) \quad \frac{\partial V}{\partial L} \Big/ \frac{\partial V}{\partial K} = \frac{1-\alpha}{\alpha} \; \frac{K}{L} - \frac{m}{\alpha} \frac{1}{A\, e^{\lambda t}} \left(\frac{K}{L} \right)^{1-\alpha}$$

This implies that when m is positive (negative), for any given K/L, $(\partial V/\partial L)/(\partial V/\partial K)$ will increase (decrease) as t rises. We also note that as t becomes large the second term of equation (5) will vanish and the expression reduces to the Cobb-Douglas case. In the Bruno model, technical change is neutral only asymptotically.

2. Elasticity of Substitution

The elasticity of substitution (σ) in the Bruno model is given by the following expression:

$$(6) \quad \sigma = 1 - \left(\frac{\alpha}{1-\alpha}\right)\frac{m}{y}.$$

When m is positive (negative), σ is less (more) then 1. As y (=V/L) increases, σ approaches 1; i.e., the model reduces to the Cobb-Douglas form.

3. Factor Share

The factor share equation implies that marginal factor shares are constant, and that the average labor share wL/V will be decreasing, constant, or increasing, depending on whether d is negative, zero, or positive.

4. Factor Market Disequilibrium

Disequilibrium in the labor market is reflected in the wage equation by the "disequilibrium parameter" q. The case p = 1, q = 0, is that of profit maximization under perfect competition. An empirically more interesting case is that of p = 1, $q < 0$. Then, $w - (\partial V/\partial L) > 0$ by a constant factor of q.[3] In a rapidly developing economy with a surplus of unskilled labor, the marginal productivity of a new entrant

---

[3] Bruno indicates that the case $p \neq 1$, q = 0 is that of imperfectly competitive equilibrium in the labor market. He "assumes" $p = 1 + 1/E_s$ where E_s is the elasticity of labor supply. This point is discussed in the next section.

into the industrial sector (e.g., from agricultural sector) would be lower than the industrial real wage rate. This point has been much argued in the literature.[4] The Bruno model is capable of empirically testing this hypothesis. This aspect of the model has an important policy implications on such matters as subsidies, and resource allocation and factor pricing.

Bruno suggests that the disequilibrium in the capital market be measured by the following expression:

$$(7) \quad \partial V/\partial K - r = -[1/(K/L)]\,(\partial V/\partial L - w),$$

where r is the rate of return on capital.

If $p = 1$ and $q < 0$, $\partial V/\partial K - r$ is positive and decreasing as K/L increases. In developing countries, the shadow rate of interest, as measured by the ~~marginal~~ productivity of capital, will tend to be greater than the bank rate or the foreign loan rate.

With the above theoretical framework in our mind, we now turn to the empirical results obtained for the three Korean industrial sectors.

---

[4] For example, see Hagen [pp. 49-50, and 394-395].

III. EMPIRICAL RESULTS[5]

The production function is estimated by the Marquardt [9] version of nonlinear regression program which uses the maximum neighborhood algorithm. For the factor share equation the ordinary least squares procedure is used. The parameter values of the wage equation are obtained by using equation (4). We shall discuss the results for the three industrial sectors and make comparisons with the Bruno's results for Israel.

1. Production Function

The estimates of the production function parameters, their confidence bounds, and the value of R^2 are shown in Table 1. For a given set of initial values of the parameters, the convergences of the parameter values were quite rapid for the electricity sector and the transportation sector.[6]

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[5] See the appendix for the nature of the data used in this study.

[6] For short, the sector including electricity, water and sanitary services will be called the electricity sector, and that of transportation, storage, and communication, the transportation sector. The composition of the value added (as % of gross national product) is as follows:

Manufacturing	26.7%
Electricity	1.9%
Water and Sanitary Service	0.3%
Transportation and Storage	4.5%
Communication	0.9%

Table 1. Estimates of the Production Function Parameters

	Manufacturing	Electricity, Water & Sanitary Services	Transportation, Storage & Communication	Israeli Manufacturing
A	0.0008 (0.0007, 0.0009)*	0.5222 (0.4925, 0.5519)	0.2934 (0.2823, 0.3045)	2.2370 (2.198, 2.277)
λ	0.2586 (0.2475, 0.2658)	0.0050 (-0.0005, 0.0099)	0.0457 (0.0404, 0.0493)	0.0127 (-0.0122, 0.0143)
α	2.2980 (2.2081, 2.3506)	0.7172 (0.6956, 0.7302)	0.5842 (0.5465, 0.5931)	0.4410 (0.383, 0.477)
m	-1.3914 (-1.4604, -1.3224)	1.0690 (0.6719, 1.4661)	1.1623 (1.0512, 1.2735)	1.6670 (1.553, 1.782)
R^2	0.9818	0.9883	0.9700	0.9536

* The numbers in parenthesis are confidence bounds at 5% level.

Table 2.1 Marginal Productivities: Manufacturing

	$\partial V/\partial L$	$\partial V/\partial K$	$(\partial V/\partial L)/(\partial V/\partial K)$
1957	1.2387	0.0328	37.7652
58	1.1067	0.0599	18.4758
59	1.1393	0.0574	19.8484
60	0.8954	0.1057	8.4711
61	0.8725	0.1105	7.8959
62	0.8621	0.1248	6.9079
63	0.9012	0.1321	6.8221
64	0.9349	0.1268	7.3730
65	0.8811	0.1626	5.4188
66	0.6855	0.2176	3.1503
67	0.6409	0.2559	2.5045
68	0.3075	0.3771	0.8154
69	-0.2176	0.5251	-0.4144
70	-0.7073	0.6527	-1.0837

Table 2.2. Marginal Productivities: Electricity, Water & Sanitary Services

	$\partial V/\partial L$	$\partial V/\partial K$	$(\partial V/\partial L)/(\partial V/\partial K)$
1957	-0.1100	0.1661	-0.6624
58	0.0454	0.1736	0.2613
59	0.0829	0.1902	0.4360
60	0.6893	0.1666	4.1384
61	0.3273	0.1542	2.1220
62	-0.4032	0.2155	-1.8711
63	0.0445	0.1415	0.3143
64	1.0757	0.1289	8.3480
65	0.7603	0.1468	5.1792
66	0.7548	0.1557	4.8478
67	0.8405	0.1603	5.2447
68	1.5579	0.1270	12.2715
69	1.8393	0.1256	14.6433
70	2.6979	0.1165	23.1497

Table 2.3. Marginal Productivities: Transportation, Storage & Communication

	$\partial V/\partial L$	$\partial V/\partial K$	$(\partial V/\partial L)/(\partial V/\partial K)$
1957	-0.2809	0.0469	-5.9893
58	-0.1235	0.0429	-2.8738
59	-0.1454	0.0489	-2.9734
60	-0.1271	0.0529	-2.4026
61	-0.2106	0.0559	-3.7674
62	-0.1299	0.0556	-2.3363
63	0.1551	0.0520	2.9827
64	0.0157	0.0628	0.2500
65	-0.0256	0.0733	-0.3492
66	0.1935	0.0704	2.7486
67	0.3089	0.0729	4.2373
68	0.3325	0.0787	4.2249
69	0.3491	0.0792	4.4078
70	0.2476	0.0818	3.0269

Table 3.1. Values of Parameters over Time: Manufacturing

	$\partial V/\partial t/V$	E_L	E_K	σ
1957	0.0202	0.8208	0.1792	-0.6323
58	0.0352	0.6871	0.3129	-0.5294
59	0.0317	0.7185	0.2815	-0.5536
60	0.0557	0.5049	0.4951	-0.3890
61	0.0577	0.4871	0.5129	-0.3753
62	0.0586	0.4792	0.5208	-0.3692
63	0.0552	0.5094	0.4906	-0.3924
64	0.0522	0.5364	0.4636	-0.4133
65	0.0570	0.4937	0.5063	-0.3803
66	0.0727	0.3542	0.6458	-0.2729
67	0.0759	0.3254	0.6746	-0.2507
68	0.0970	0.1381	0.8619	-0.1064
69	0.1218	-0.0827	1.0827	0.0637
70	0.1390	-0.2351	1.2351	0.1811

Table 3.2. Values of Parameters over Time: Electricity, Water, and Sanitary Services

	$\partial V/\partial t/V$	E_L	E_K	σ
1957	0.0073	-0.0474	1.0474	-0.1677
58	0.0069	0.0158	0.9842	0.0559
59	0.0068	0.0276	0.9724	0.0976
60	0.0060	0.1339	0.8661	0.4734
61	0.0064	0.0846	0.9154	0.2993
62	0.0092	-0.3137	1.3137	-1.1093
63	0.0069	0.0155	0.9845	0.0550
64	0.0058	0.1651	0.8349	0.5839
65	0.0060	0.1408	0.8592	0.4980
66	0.0060	0.1403	0.8597	0.4961
67	0.0059	0.1479	0.8521	0.5229
68	0.0057	0.1895	0.8105	0.6702
69	0.0056	0.1996	0.8004	0.7058
70	0.0054	0.2202	0.7798	0.7787

Table 3.3. Values of Parameters over Time: Transportation, Storage and Communication

	$\partial V/\partial t/V$	E_L	E_K	σ
1957	0.1012	-0.2934	1.2934	-0.7057
58	0.0855	-0.0924	1.0924	-0.2221
59	0.0871	-0.1133	1.1133	-0.2725
60	0.0857	-0.958	1.0958	-0.2304
61	0.0929	-0.1870	1.1870	-0.4498
62	0.0859	-0.0984	1.0984	-0.2367
63	0.0722	0.0773	0.9227	0.1859
64	0.0775	0.0094	0.9906	0.0226
65	0.0795	-0.0163	1.0163	-0.0391
66	0.0710	0.0922	0.9078	0.2218
67	0.0681	0.1300	0.8700	0.3127
68	0.0675	0.1367	0.8633	0.3287
69	0.0672	0.1412	0.8588	0.3395
70	0.0695	0.1111	0.8[illegible]	0.2671

It took 5 iterations for the electricity sector for the parameter set to converge and 67 iterations for the transportation sector. In the case of electricity the value of R^2 increased from 0.355 at the first iteration to 0.988 at the fifth, while in the transportation case the value stayed at 0.970 from the 10th iteration through the 67th, with minor variations among the parameter values. Therefore, it was not difficult to obtain the "best" set of parameters for these two sectors.

On the other hand, in the case of the manufacturing sector it took 144 iterations for the parameter set to converge. The value of R^2 increased from 0.9074 at the third iteration to 0.9818 at the terminal, with the values of parameters undergoing wide range of variations. We shall examine the production function estimates and make appropriate analyses.

In Table 1, we note that m is negative in the manufacturing sector and positive in the other two sectors. As we have seen in Section 2, the direction of changes in the ratio of marginal productivities over time depends on the sign of m; i.e., if $m < 0$, $(\partial V/\partial L)/(\partial V/\partial K)$ will decrease as t becomes large. This ratio has been computed and reported in Table 2. The values of the marginal productivities are obtained by using the values of the elasticities shown in Table 3. From the Bruno production function, the capital elasticity is derived as

$$(8) \quad E_K = \alpha (1 + m/y), \text{ and}$$

$$E_L = 1 - E_K$$

for the labor elasticity.

According to our results, the manufacturing sector has experienced an absolute decline in the marginal productivity of labor and an increase in the marginal productivity of capital; hence, the decreasing ratio of $(\partial V/\partial L)/(\partial V/\partial K)$. The trends in the electricity sector have been opposite to those in the manufacturing sector. In the transportation sector, however, the marginal productivities of both factors have been rising, but that of labor faster than that of capital. We also observe that the trend of $(\partial V/\partial L)/(\partial V/\partial K)$ is consistent with the trend of K/L[7], although the latter does not show a strong trend in the transportation sector.

The trends of marginal productivities in the manufacturing sector may be evidence to the effect that the rapid growth of the Korean manufacturing sector has been largely dependent upon highly advanced foreign technology rather than improvement of domestic manpower resources. The labor absorbed into the manufacturing sector out of nonindustrial sectors must not have been able to catch up with the increasing use of advanced technology. The Korean manufacturing sector does not seem to have experienced Bruno's 'learning process' which he observed from the Israel study.[8]

At this point we should note that in Table 1 the value of α for the manufacturing sector is greater than 1. This does not violate the positive marginal productivity condition, but the second order condition (i.e., diminishing marginal productivities) is not satisfied.

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[7] For the time-series on K/L, V/L, K/V, and w see Table 11 in the appendix.

[8] See Bruno (72, p. 53).

This may be an indication that the firms are operating on the decreasing portion of the average cost curve with some degree of excess capacity, or the firms are experiencing increasing returns to scale.

The values of the elasticity of substitution, computed by using equation (6), appear in Table 3. Note that σ is a function of $y(=V/L)$. The value of σ turned out to be negative for all three sectors in 1957 when the value added per man was low. Of course σ is not defined in the negative region. As y increases σ has become larger; and the sign becomes positive, but not until 1969 in the manufacturing sector. The σ value for 1970 is 0.18, 0.78, and 0.27, in the manufacturing, electricity, and transportation, respectively. These low values of σ indicate the lack of substitutability of factors in Korea.[9]

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[9] The value of σ ranges from 0.58 to 0.76 in the Israeli manufacturing sector. Alternative estimates of σ are obtained by taking the regression of ln V/L on ln w. The values of σ are 1.0064, 1.0212, 1.1671, and 1.1904, for the manufacturing, electricity, transportation, and the Israeli manufacturing, respectively. All four estimates are statistically significant, and the values are close to 1, while our estimates of σ in the Bruno model were substantially below 1. The assumption of competitive equilibrium in this CES procedure seems to overstate σ. Nevertheless, this procedure has been widely used in the literature to estimate σ, [1, 13].

2. Factor Share Equation

Table 4 shows the regression estimates of the coefficients of the factor share equation. The estimate of c is statistically significant for all three sectors, but that of d is significant only in the case of transportation. However, the negative sign of d in the manufacturing sector seems to confirm the trend of labor share figures[10] shown in Table 5. The downward trend of the labor share in this sector can be detected in Figure 1.

3. Wage Equation

The values of p and q are obtained by substituting the values of α, m, c, and d into equation (4). The confidence bounds for p and q are approximated also by the use of equation (4). These results are reported in Table 4. The value of p is very close to 1 in the electricity sector and transportation sector as in the case of Israeli manufacturing. q has negative sign in these two sectors, but the magnitudes are smaller than that of Israeli manufacturing.

In the case of the Korean manufacturing sector, however, p is negative and q is positive, which does not seem to make much sense. Nevertheless, we can do the following exercise in order to obtain an

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10 The labor share is estimated by wL/V, and return to capital is approximated by (V - wL)/K. All three sectors show downward trend in wL/V. The return to capital increases rapidly in manufacturing and transportation. Further analysis on the return to capital will be made in the wage equation section.

Table 4. Estimates of the Factor Share Equation and Wage Equation

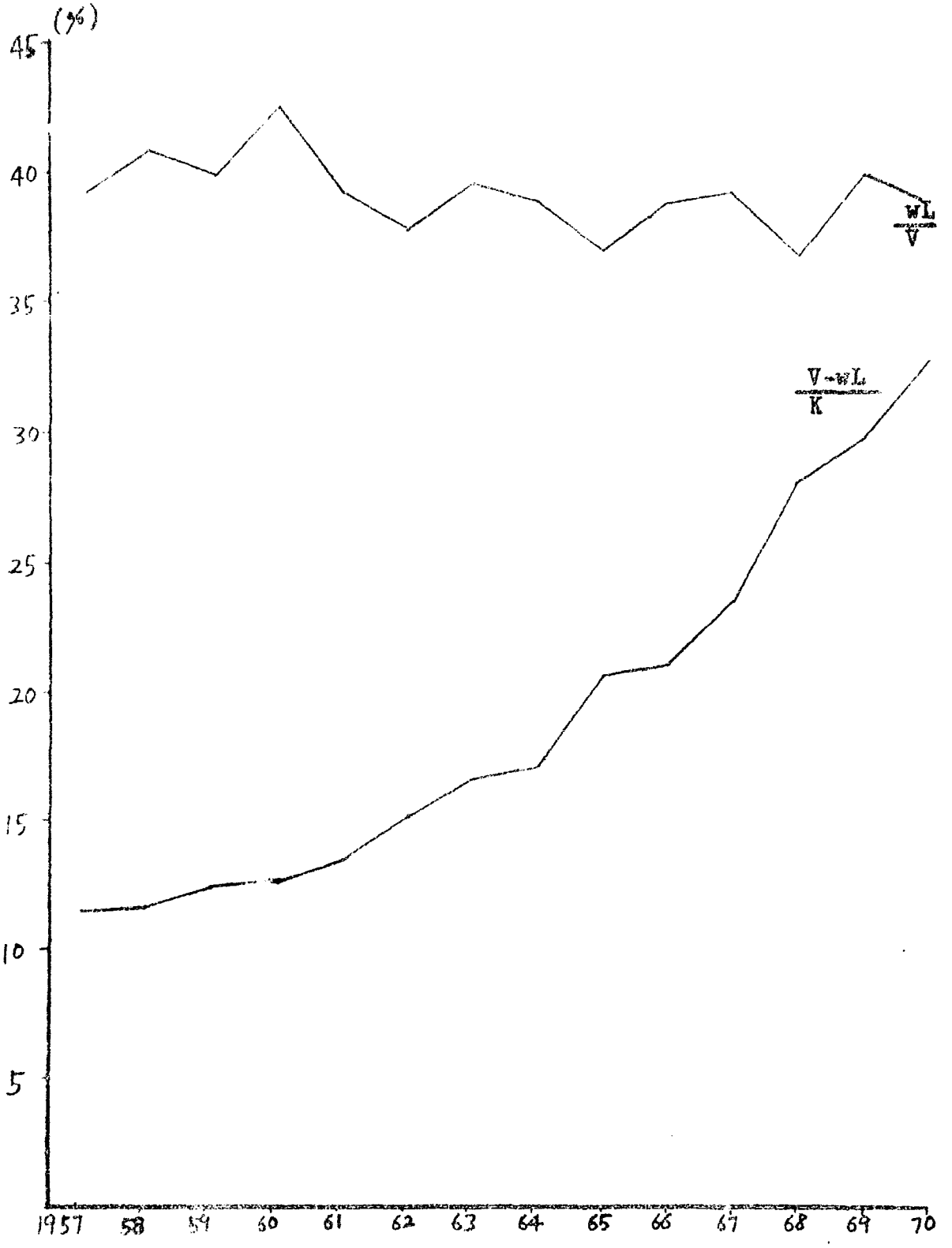
	Manufacturing	Electricity, Water & Sanitary Services	Transportation, Storage & Communication	Israeli Manufacturing
Factor share equation				
c	2.6016 (0.1286)*	3.0967 (0.4697)	2.3870 (0.1616)	1.750 (1.566, 1.954)
d	-0.0129 (0.0985)	0.0513 (0.8848)	-0.2690 (0.1393)	-0.750 (-0.916, -0.584)
R^2	0.9715	0.7837	0.9479	
DW	2.0506	0.8773	1.1874	
Wage equation				
p	-3.3769 (-3.5137, -3.1430)	0.8757 (0.8355, 0.9426)	0.9925 (0.9712, 1.0825)	0.9783 (0.855, 1.206)
q	3.2141 (3.0880, 3.2880)	0.7522 (-0.7668, -0.7280)	-0.7907 (-0.7989, -0.7572)	-1.1544 (-1.362, -0.918)

* The paired numbers in parenthesis are confidence bounds, and the single numbers are standard errors.

Table 5. Labor share and Returns to Capital (%)

	Manufacturing		Electricity, Water & Sanitary Services		Transportation, Storage & Communication	
	wL/V	(V-wL)/K	wL/V	(V-wL)/K	wL/V	(V-wL)/K
1957	38.78	11.21	41.16	9.33	55.33	1.62
58	40.45	11.40	32.39	11.93	55.45	1.75
59	39.34	12.37	38.60	12.01	55.95	1.93
60	42.11	12.36	56.63	8.34	50.98	2.36
61	38.77	13.19	41.92	9.79	50.75	2.32
62	37.49	14.97	35.63	10.56	45.34	2.77
63	39.21	16.36	31.27	9.88	47.72	2.95
64	38.54	16.81	30.93	10.66	49.43	3.21
65	36.55	20.37	26.51	12.56	48.94	3.68
66	38.57	20.69	24.10	13.75	42.10	4.49
67	38.73	23.24	29.23	13.31	45.54	4.56
68	36.33	27.85	27.43	11.37	44.81	5.03
69	39.32	29.43	28.75	11.18	47.16	4.87
70	38.34	32.58	27.98	10.76	49.78	4.62
mean	38.75	18.77	33.75	11.10	49.23	3.30

Figure 1. Labor Share and Return to Capital in the Manufacturing Sector



alternative interpretation on the manufacturing wage equation. Using the values of p and q in Table 4 and the wage data, we can compute the values of $\partial V/\partial L$ from the estimated wage equation. Then we can observe the discrepancies between this "independently" obtained series on $\partial V/\partial L$[11]; say $(\partial V/\partial L)^*$, and the wage rate series over time. The magnitudes of the discrepancies so obtained may be viewed as an approximation of the values of q[12]; say, q^*. The values of $(\partial V/\partial L)^*$ and q^* are reported in Table 6.

It is interesting to note that the values of $(\partial V/\partial L)^*$ in Table 6 closely confirm the corresponding values of $(\partial V/\partial L)$ in Table 2.1. The q^* takes negative value from 1966 and the magnitude is increasing. The average value of q^* during the sample period is negative. If we can accept the above procedure, we may conclude that there is a positive discrepancy between w and $\partial V/\partial L$ (i.e., $\partial V/\partial L - w < 0$) in the manufacturing sector as well as in the other two sectors, and that the extent of the labor market disequilibrium in the manufacturing sector ($q^* = -0.07$) is smaller than that of the other two sectors ($q = -0.8$). The above

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[11] The values of $\partial V/\partial L$ in Table 2 were obtained from the values of E_L, using equation (8) which did not involve wage variable.

[12] Since $q^* = (\partial V/\partial L)^* - w$, here we are implicitly assuming that p is close to 1. Bruno assumes that $p = 1 + 1/E_s$, where E_s is the elasticity of labor supply. $p < 0$ implies $E_s < 0$. If $p = -3.4$ (in Table 4), then $E_s = -0.2285$. One may be tempted to interpret this as the existence of "backward-bending" labor supply, which may be plausible in a developing country.

Table 6. The values of $(\partial V/\partial L)^*$ and q^*: Manufacturing

	$(\partial V/\partial L)^*$	q^*
1957	1.2379	0.6527
58	1.0140	0.3625
59	1.1076	0.4838
60	0.6919	-0.0550
61	0.8688	0.1743
62	0.9364	0.2619
63	0.8715	0.1778
64	0.9455	0.2737
65	1.0113	0.3590
66	0.6932	-0.0533
67	0.6379	-0.1250
68	0.4822	-0.3268
69	-0.2790	-1.3134
70	-0.6808	-1.8342
mean		-0.0687

evidence indicates that the industrial wage rate is higher than the productivities of marginal workers coming from the nonindustrial sectors.[13]

Now we turn to the capital market side. Equation (7) can be written as[14]

(9) $\partial V/\partial K - r = -q/(K/L)$.

Let $\partial V/\partial K - r = h$. If $q<0$, then $h>0$, and h increases (decreases) as K/L falls (rises). Using the average value of K/L and the average values of q^* (for manufacturing) and q (for the other two sectors), we obtained the following values of h: 0.0102, 0.0234, and 0.0288 for manufacturing, electricity, and transportation, respectively. This is evidence to the effect that in all three sectors there has been a positive discrepancy between the marginal productivity of capital[15] and the rate of return, as in the case of the Israeli manufacturing

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[13] Similar findings are obtained by W. T. Hong [7] from cross-section data in his tax-cum-subsidy project at KDI.

[14] $p = 1$ was assumed in equation (7).

[15] In order to check the accuracy of this measures, we have computed the marginal productivity of capital from equation (9); i.e., $(\partial V/\partial K)^* = h + r$. $(V - wL)/K$ is used for r. The average values of $(\partial V/\partial K)^*$ are 0.1979, 0.1344, and 0.0618, for manufacturing, electricity, and transportation, respectively. These values closely confirm the average values of $\partial V/\partial K$ in Table 2. Remember that the computation of $\partial V/\partial K$ in Table 2 using equation (8) did not involve $(V - wL)/K$. (See also footnote 11 and corresponding results.) These consistencies among the numerical values we have obtained reflect the internal consistencies between the model and our estimates and data, even though the production function and the factor share equation were not simultaneously estiamted.

sector. The extent of the capital market disequilibrium is greater in the electricity and transportation sectors than in the manufacturing sector.

Our findings indicate that in the Korean industrial sectors, while the shadow price of labor is lower than the industrial wage rate, that of capital is greater than the rate of return. In Korea, as in other developing countries, the rate of interest charged on the government development loans and foreign loans tends to be very low and lower than the shadow rate of interest.

The values of $(\partial V/\partial K)^*$ and h are computed for the manufacturing sector for the sample period and are reported in Table 7. The values of $(\partial V/\partial K)^*$ closely confirm those of $(\partial V/\partial K)$ in Table 2.1. It is interesting to note that the sign of both q^* and h changed in 1966.[16] This seems to reflect that the factor markets in the manufacturing sector had experienced a drastic structural changes in 1966.

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[16] See Table 8 for the marked changes in the average annual growth rates of V and K between the two periods before and after 1965. 1966 was also the terminal year of the first five year economic plan.

Table 7. The Values of $(\partial V/\partial K)^*$ and h: Manufacturing

	$(\partial V/\partial K)^*$	h
1957	0.0329	-0.0792
58	0.0709	-0.0431
59	0.0615	-0.0622
60	0.1302	0.0066
61	0.1109	-0.0210
62	0.1148	-0.0349
63	0.1365	-0.0271
64	0.1251	-0.0430
65	0.1391	-0.0646
66	0.2162	0.0093
67	0.2565	0.0241
68	0.3427	0.0642
69	0.5364	0.2421
70	0.6480	0.3222

4. Factor Contributions to Growth

We shall now examine the relative factor contributions to growth and technical change on the basis of the estimates obtained above. The following growth equation is used for the analysis:

$$(10) \quad \dot{V}/V = (\partial V/\partial t)(1/V) + E_L\,(\dot{L}/L) + E_K\,(\dot{K}/K),$$

where $(\partial V/\partial t)(1/V) = \lambda(1 + m/y)$; E_L and E_K are elasticities as defined before.[17]

The average annual growth rates for the sample period (1957-70) and sub-periods appear in Table 8. The figures for the sub-periods indicate that there has been a good deal of variation in the growth rates over time. We shall examine the implications for the entire sample period first and then for the sub-periods.

The proportions of the output growth rate contributed by the total productivity factor, labor, and capital appear in Table 9. The figures in the "mean" column are obtained by use of the mean value of y.

In the manufacturing sector the estimates of the elasticities are 0.3515 for labor and 0.6485 for capital. The estimated contribution to growth is 20.95%, and 25.14% by labor and capital, respectively. The contribution of labor has decreased over time, while that of capital has increased.[18] According to our results, about 50% of the output

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[17] If m is positive (negative), the "total productivity" factor decreases (increases) over time, as y increases.

[18] See Table 3 for the annual figures of E_L and E_K, and Table 11 for the time-series on y (= V/L).

Table 8. Average Annual Growth Rates (%) of V, K, L, and w

	57-62	62-65	65-68	68-70	57-68	57-70
Manufacturing						
V	8.27	14.50	22.58	20.08	13.72	14.68
K	2.60	3.85	10.57	9.26	5.06	5.69
L	4.53	14.81	13.86	3.31	9.77	8.75
w	2.88	-1.11	7.44	19.40	2.99	5.36
Electricity, Water & Sanitary Services						
V	12.55	18.09	23.49	25.91	16.95	18.29
K	11.79	16.05	27.12	28.91	17.09	18.83
L	26.67	-26.81	7.34	3.14	4.25	4.08
w	-13.68	46.21	16.36	23.29	8.12	10.33
Transportation, Storage & Communication						
V	9.99	16.99	20.90	16.08	14.78	14.98
K	2.89	3.96	11.84	15.56	5.55	7.04
L	3.14	10.40	4.52	21.29	5.45	7.74
w	2.48	8.71	12.32	0.88	6.78	5.85

Table 9.1. Productivities, Factor Contributions and Elasticity of Substitution: Manufacturing

	1957	1970	mean
y	1.5091	3.0083	1.9383
m/y	-0.9220	-0.4625	-0.7178
A) $\partial V/\partial t/V$	0.0202	0.1390	0.0730
$A/(\dot{V}/V)$	13.76%	94.69%	49.73%
E_L	0.8208	-0.2352	0.3515
B) $E_L(\dot{L}/L)$	7.1802%	-2.0580%	3.0756%
$B/(\dot{V}/V)$	48.91%	-14.02%	20.95%
E_K	0.1792	1.2352	0.6485
C) $E_K(\dot{K}/K)$	1.0196%	7.0283%	3.6900%
$C/(\dot{V}/V)$	6.95%	47.88%	25.14%
σ	-0.6323	0.1812	-0.2708

Table 9.2. Productivities, Factor Contributions, and Elasticity of Substitution: Electricity, Water & Sanitary Services

	1957	1970	mean
y	2.3217	12.2520	5.2882
m/y	0.4604	0.0873	0.2021
A) $\partial V/\partial t/V$	0.0073	0.0054	0.0060
$A/(\mathring{V}/V)$	3.99%	2.95%	3.28%
E_L	-0.0474	0.2202	0.1379
B) $E_L(\mathring{L}/L)$	-0.1934%	0.8984%	0.5626%
$B/(\mathring{V}/V)$	-1.06%	4.91%	3.08%
E_K	1.0474	0.7798	0.8621
C) $E_K(\mathring{K}/K)$	19.7225%	14.6836%	16.2333%
$C/(\mathring{V}/V)$	107.83%	80.28%	88.76%
σ	-0.1676	0.7786	0.4875

Table 9.3. **Productivities, Factor Contributions and Elasticity of Substitution: Transportation, Storage and Communication**

	1957	1970	mean
y	0.9574	2.2282	1.7291
m/y	1.2140	0.5216	0.6722
A) $\partial V/\partial t/V$	0.1012	0.0695	0.0764
$A/(\mathring{V}/V)$	67.56%	46.40%	51.00%
E_L	-0.2934	0.1111	0.0231
B) $E_L(\mathring{L}/L)$	-2.2709%	0.8599%	0.1788%
$B/(\mathring{V}/V)$	-15.16%	5.74%	1.19%
E_K	1.2934	0.8889	0.9769
C) $E_K(\mathring{K}/K)$	9.1055%	6.2579%	6.8774%
$C/(\mathring{V}/V)$	60.78%	41.78%	45.91%
σ	-0.7057	0.2672	0.0556

Table 9.4. Productivities, Factor Contributions and Elasticity of Substitution: Israeli Manufacturing

	1953	1964	mean
y	3.1014	5.4081	4.1395
m/y	0.5375	0.3082	0.4027
A) $\partial V/\partial t/V$	0.0195	0.0166	0.0178
$A/(\mathring{V}/V)$	16.25%	13.83%	14.83%
E_L	0.3218	0.4231	0.3814
B) $E_L(\mathring{L}/L)$	2.0917%	2.7502%	2.4791%
$B/(\mathring{V}/V)$	17.43%	22.92%	20.66%
E_K	0.6782	0.5769	0.6186
C) $E_K(\mathring{K}/K)$	8.1384%	6.9228%	7.4232%
$C/(\mathring{V}/V)$	67.82%	57.69%	61.86%
σ	0.5760	0.7569	0.6823

growth has been due to the "total productivity" factor.[19] This factor has increased about 7 times in the period studied. The value of $(\partial V/\partial t)(1/V)$ has increased from 0.0202 in 1957 to 0.1390 in 1970 (see Table 3.1). In the Israeli manufacturing sector, however, Bruno observed that this value declined from 0.0195 to 0.0166 during his sample period (1953-1964), and the contribution of the total factor productivity decreased from 16.25% to 13.83%.

In the electricity sector, almost 90% of the growth has been contributed by capital. The contribution by labor is only 3.08% and that of total productivity factor is as low as 3.28%. Contrary to the case of manufacturing, the elasticity of labor in this sector has increased over time and that of capital has decreased. This trends are similar to the Israeli manufacturing case (see Table 9.4). This may be evidence to the effect that technical change is biased towards labor augmentation in the Korean electricity sector, as in the case of Israeli manufacturing. In the Korean manufacturing, K/V has decreased steadily from 5.46 to 1.89 in the sample period.[20] In the electricity sector, however, K/V has been fairly constant, as in the case of Israeli manufacturing. In the Korean manufacturing sector, V/L has only doubled between 1957 and 1970, while it has increased more than 5 times in the electricity

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[19] Y. B. Kim [8] at KDI estimated the Cobb-Douglas production function with a real cash balance variable as a factor of production to capture the capacity utilization rate. His estimates for the factor contribution (1957-71) were 21.4% for capital, 12.6% for labor, 13.5% for the real cash balances (money supply is used as a proxy), and 50.6% for the total productivity factor.

[20] See Table 11 for the different ratios of the variables.

sector during the same period. In the Israeli manufacturing sector, V/L increased from 3.1 to 5.4 during the period 1953-64. This general picture supports our estimated results.

In the transportation sector, although both $\partial V/\partial L$ and $\partial V/\partial K$ have increased during the period (see Table 2.3), E_K has decreased because the rate of decrease in K/V has been faster than the rate of increase in $\partial V/\partial K$. In this sector also, labor shows little contribution (1.19%) to growth while capital has contributed 45.91%. The total productivity factor has decreased, as in the case of transportation and Israeli manufacturing.

The "total productivity" factor (or the "residual" element) explains about 50% of the output growth in the manufacturing and the transportatio sectors in this study. Bruton [3], however, found that the average estimate of the "residual" factors for five Latin American countries was only 26%, while the figure was 58% for a group of advanced countries. Contrary to the case of the Latin American countries, our results seem to confirm "the frequently encountered notion that less developed countries with a somewhat primitive technological base may reap large windfalls by exploiting recently developed knowledge."[21]

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[21] Bruton [3, p. 1102]; We also note that Bruton's estimate of the capital share in the manufacturing sector of the Latin American countries was also above 60% as in the Korean manufacturing, and the importance of the growth of capital is suggested in his analysis.

The estimates reported in column 1 and 2 in Table 9 are obtained by applying the growth rates of the entire sample period (1957-70) but by using the observed y for the year 1957 and 1970, respectively. To see the general trend of the contribution of each factor to growth over time it would be more appropriate to look at the contribution of factors by sub-periods. Table 10 reports the estimates for 4 sub-periods; namely, 57-62, 62-65, 65-68, and 68-70. The mean value of y (hence, the mean estimates of E_L and E_K) is used for the estimates of the sub-periods.

In Table 10, however, we do not find consistent trends in the contribution of factors over time. In the manufacturing sector, we observe that both the capital contribution and the total productivity factor have steadily increased from the second sub-period. This picture is quite different from the observations made by Bruton [3] on Latin American countries and by Williamson [12] on the Philippines. Both of them observed that the contribution of total productivity has been decreasing over time with increasing rate of capital formation, the villains being "resource misallocation and underutilization of all factors accompanying an excessive import substitution policy."[22] If we can accept the Bruton's suggestion that the rate of growth of total productivity is dependent upon changes in the degree of utilization[23],

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[22] Williamson [12, p. 107], and also see Bruton [3, pp. 1110-1115].

[23] Bruton [3, p. 1108].

Table 10. Factor Contributions for Different Time Periods Using E_L & E_K

(%)	57-62	62-65	65-68	68-70	57-68
Manufacturing					
A) $E_K(\dot{K}/K)$	1.6861	2.4967	6.8546	6.0051	3.2814
B) $E_L(\dot{L}/L)$	1.5923	5.2057	4.8718	1.1635	3.4342
C) $\dot{V}/V$ - (A+B)	4.9916	6.7976	10.8536	12.9114	7.0044
A/($\dot{V}/V$)	20.39	17.22	30.36	29.91	23.92
B/($\dot{V}/V$)	19.25	35.90	21.58	5.79	25.03
C/($\dot{V}/V$)	60.36	46.88	48.07	64.30	51.05
Electricity, Water & Sanitary Services					
A) $E_K(\dot{K}/K)$	10.1642	13.8367	23.3802	24.9233	14.7333
B) $E_L(\dot{L}/L)$	3.6778	-3.6971	1.0122	0.4330	0.5861
C) $\dot{V}/V$ - (A+B)	-1.2920	7.9504	-0.9024	0.5537	1.6306
A/($\dot{V}/V$)	80.99	76.49	99.53	96.19	86.92
B/($\dot{V}/V$)	29.31	-20.44	4.31	1.67	3.46
C/($\dot{V}/V$)	-10.29	43.95	-3.84	2.14	9.62
Transportation, Storage & Communication					
A) $E_K(\dot{K}/K)$	2.8232	3.8685	11.5665	15.2006	5.4218
B) $E_L(\dot{L}/L)$	0.0725	0.2402	0.1044	0.4918	0.1259
C) $\dot{V}/V$ - (A+B)	7.0943	12.8813	9.2291	0.3876	9.2323
A/($\dot{V}/V$)	28.26	22.77	55.34	94.53	36.68
B/($\dot{V}/V$)	0.73	1.41	0.50	3.06	0.85
C/($\dot{V}/V$)	71.01	75.82	44.16	2.41	62.46

we must conclude that the level of excess capacity has been reduced in the Korean manufacturing in the 60's.

However, one puzzling factor is the decreasing rate of growth of manufacturing employment in recent years. In fact, the capital-labor ratio has been decreasing until 1968; it starts increasing thereafter. In the period 1965-1968, the growth rate of labor was 13.86%; then it dropped to 3.31% in the period 1968-1970. This may be an indication that the rapid labor absorption rate has been tapering off in the late 60's as capacity is becoming more fully utilized.

In their studies, Bruton and Williamson were able to reject the hypothesis that "the gains associated with a movement towards optimal resource allocation are small."[24] Bruton concludes his paper stating that "if, however, productivity growth is an important element in development, and if it is handicapped by severe misallocations, then the solving of the allocation problem in a satisfactory way is a crucial element in development policy."[25] To check the extent of resource misallocations in the Korean manufacturing, we turn to our findings on the factor market disequilibrium.

In Table 6 the discrepancy between $\partial V/\partial L$ and w (i.e., q^*) becomes negative in 1966 and the magnitude increases thereafter.[26] In Table 7, the discrepancy between $\partial V/\partial K$ and r (i.e., h) becomes positive in 1966 and the magnitude of h also increases. This implies that the extent

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[24] Williamson [12, p. 109]

[25] Bruton [3, p. 1115].

[26] The values of q are consistently negative in the other two sectors during the sample period.

of factor market disequilibrium (that is , the degree of misallocation) has been rising in the late 60's. This sharply contridict the findings by Bruton and Williamson. I must conclude that the rise in total factor productivity in the Korean manufacturing sector was independent of the increasing degree of the factor market disequilibrium, even though the policy enviornment in Korea was quite similar to the Latin American countries.

Of course, this argument by no means implies that the factor market disequilibrium is necessarily desirable for increasing total factor productivity. The degree of factor market disequilibrium may be tolerable to the extend that producers paying a wage rate which is higher than the shadow price of labor are subsidized by the interest rate which is lower than the shadow rate of interest, in a situation where the flows of foreign capital are easily accessible and skilled labor is hard to come by. The natural upper limit to this factor market distortion would be the foreign exchange constraint, shortage of skilled labor, and inflation caused by the lack of a proper product mix for the domestic market.

Although total factor productivity has increased in spite of the factor market disequilibrium, the efficient allocation of domestic resources will remain as a serious problem in Korea for sustaining "stable" growth in the coming years. The most serious bottleneck to the future growth in Korea seems to be the shortage of skilled manpower resources.

Now a few comments are appropriate here for the other two sectors studied. In Table 10, it is difficult to detect any definite trends

in factor contributions in the electricity sector over the sub-periods. Although both the marginal productivity of labor and the labor elasticity have increased in the late 60's (see Table 2.2 and 3.2), labor's contribution to growth has declined. This is due to the falling rate of growth in the level of labor input in the late 60's. From the second sub-period to the third, the rate of capital formation increased, while the total productivity factor decreased from 43.95% to -3.84%. This comes very close to the observations made by Bruno and Williamson for other countries. A good deal of the electric facilities were built in the mid 60's and the demand for electricity has been lagging behind.

In the transportation sector, the trends of factor contributions are fairly consistent. The capital contribution has increased sharply, due primarily to the rapid increase in the stock of capital rather than the productivity of capital. The rate of growth of capital increased from 3.96% in the early 60's to 15.56% in the late 60's, while the capital elasticity stayed fairly constant. Over the same period, however, this sector has experienced a sharp decline in total factor productivity; namely, from 75.82% in the early 60's to 2.41% in the late 60's. This may suggest that there has been an increasing level of excess capacity in the transportation sector. Although the rate of employment increased markedly in the last sub-period, both the marginal productivity of labor and the labor elasticity stayed fairly constant. It is significant to note that in this sector the wage growth rate dropped from 12.32% to 0.88% in the late 60's.

IV. SUMMARY AND CONCLUDING REMARKS

The Bruno production function is estimated along with the factor market disequilibrium side-condition for the three industrial sectors in Korea; namely, manufacturing, electricity, and transportation. The annual time-series data for the period 1957-70 are used. The findings in this study can be summarized as follows.

1. The trends of the marginal productivities imply that technical change has been non-neutral in all three sectors. Technical change seems to be biased towards capital augmentation in the manufacturing sector, while it seems to be biased towards labor augmentation in the other two sectors.

A note on the size structure of the Korean manufacturing is appropriate here. The rapid growth of manufacturing output in the 60's has been largely due to the expansion of the large-scale industries (i.e., firms with more than 200 employees), which consisted of only 2.6% of the total manufacturing firms in 1970. In the late 60's, 70% of total manufacturing output was produced by the large-scale firms, and the economic structure in the Korean manufacturing sector has been very much dominated by this group. The large firms in general tend to be capital intensive and heavily dependent upon highly advanced foreign technology. This environment would not have provided enough room for labor augmenting technical change. It seems to be necessary to estimate separate production functions at a disaggregated level according to the size of firms. For small industries which should

be highly labor intensive, we may find results that may contradict our findings in this study.

2. In all three sectors, the elasticity of substitution is very low. In the Bruno model the elasticity of substitution is a function of V/L. This parameter seems to detect the factor substitutability at different stages of development. In 1970, the value of σ was 0.18, 0.78, and 0.27, in manufacturing, electricity, and transportation, respectively. The Korean industrial sector seems to remain far from the Cobb-Douglas world. The widely used method of taking a regression of ln V/L on ln w seems to overestimate σ. (see footnote 9). The low value of σ suggests that there exists a wide gap between the level of technology and the level of labor skills. The lack of innovation and the development of intermediate technology is reflected here.

3. Although the factor share parameter d was statistically significant only for the transportation sector, we have observed decreasing trends of labor share in all three sectors.

4. Our evidence shows that in all three sectors the shadow price of labor is lower than the wage rate and that of capital is greater than its rate of return. The gap between the market price and the shadow price of labor is due to the downward rigidity of the industrial wage rate and the low productivity of marginal workers coming from the nonindustrial sectors. One way of closing this gap will be through an efficient program of on the job training. The government could subsidize the price of labor through such a program.

The disequilibrium in the capital market must be the outcome of increasing reliance of easily accessible foreign capital at low rates of interest and the interest subsidies given to large-scale firms through government investment loans. On the other hand, small-scale firms have to pay the private loan rate which could have been higher than the shadow rate. Factor market disequilibrium resulting from specific policy measures could also distort the output mix, and the industrial structure could become inconsistent with factor endowments. In the 60's, it was possible to sustain a high rate of growth through the imports of foreign capital and advanced foreign technology. However, it is very unlikely that this trend will persist in the 70's, primarily due to the foreign exchange constraint and to the costs to be paid for the distortion of both the factor and the product markets. In Table 7 we have seen that the gap between the shadow price of capital and the rate of return had been widening in recent years. It seems to be quite urgent to mitigate this tendency in order to sustain a "stable" rate of growth.

5. In all three sectors the [illegible]tribution of capital to growth was higher than that of labor. Labor [illegible]contribution to growth was very small in the electricity and the transportation sectors. In the manufacturing and the transportation sectors, about 50% of the growth was due to the total productivity factor while it was only about [illegible]% in the electricity sector. Contrary to Bruton's findings for the Latin American countries, in the Korean manufacturing sector the total productivity has increased along with an increasing [illegible] capital

formation. According to Bruton's argument, this implies that the degree of utilization has been rising in the Korean manufacturing sector, and the level of excess capacity was not high enough to prevent innovative activities. Our findings suggest that the factor market disequilibrium (misallocation of resources) did not seem to affect the growth of the total productivity in the manufacturing sector. This contradicts the observations made by Bruton and Williamson for other countries. However, the trends of the total productivity and the rate of capital formation in the other two sectors imply that there has been an increasing level of excess capacity in these sectors,

DATA APPENDIX

Definitions and Sources :

V : Industrial origin of gross national product, in billion won (1965 = 100). National Income and Statistics Yearbook, The Bank of Korea.

L : The number of persons employed, in 10 thousand of persons, Annual Report on the Economically Active Population, Economic Planning Board. The series before 1963 were constructed at KDI on the basis of the raw data.

K : Constructed for this study at KDI by the use of the series on gross domestic capital formation, in billion won (1965 = 100), National Income and Statistics Yearbook. The 1968 capital stock figures prepared by K. C. Han [6] of Yonsei University were used as the benchmark.

w : Annual compensation per employee, in 10 thousand won (1965 = 100), National Income Statistics Yearbook. The unit used in the actual computation in this study was in 100 thousand won.

Table 11.1. V/L, K/L, K/V, and w (1965 = 100): Manufacturing

	V/L (100 thousand won)	K/L (100 thousand won)	K/V (won)	w (10 thousand won)
1957	1.5091	8.2436	5.4627	5.852
58	1.6107	8.4127	5.2231	6.515
59	1.5856	7.7743	4.9029	6.238
60	1.7735	8.3044	4.6826	7.469
61	1.7912	8.3176	4.6437	6.945
62	1.7991	7.5100	4.1744	6.745
63	1.7691	6.5719	3.7149	6.937
64	1.7430	6.3712	3.6553	6.718
65	1.7846	5.5576	3.1143	6.523
66	1.9353	5.7449	2.9684	7.465
67	1.9696	5.1918	2.6360	7.629
68	2.2265	5.0892	2.2857	8.090
69	2.6309	5.4245	2.0619	10.344
70	3.0083	5.6926	1.8923	11.534
Mean	1.9383	6.7290	3.6727	7.5003

Table 11.2. V/L, K/L, K/V, and w (1965 = 100)
Electricity, Water & Sanitary Services

	V/L (100 thousand won)	K/L (100 thousand won)	K/V (won)	W (10 thousand won)
1957	2.3217	14.6366	6.3043	9.556
58	2.8717	16.2797	5.6690	9.301
59	3.0043	15.3609	5.1129	11.598
60	5.1478	26.7686	5.2000	29.154
61	3.8690	22.9613	5.9346	16.220
62	1.2853	7.8358	6.0963	4.580
63	2.8687	19.9636	6.9592	8.970
64	6.5154	42.2154	6.4793	20.154
65	5.4000	31.6053	5.8528	14.316
66	5.3802	29.7055	5.5212	12.967
67	5.6829	30.2162	5.3171	16.613
68	8.2213	52.4851	6.3841	22.553
69	9.2147	58.7193	6.3724	26.495
70	12.2520	81.9800	6.6912	34.280
mean	5.2882	32.1952	5.9925	169.112

Table 11.3. V/L, K/L, K/V, and w (1965 = 100): Transportation, Storage & Communication

	V/L (100 thousand won)	K/L (100 thousand won)	K/V (won)	$\dot{w}$ (10 thousand won)
1957	0.9574	26.3977	27.5726	5.298
58	1.3362	34.0203	25.4599	7.410
59	1.2833	29.2450	22.7895	7.180
60	1.3272	27.5099	20.7272	6.766
61	1.1264	23.9069	21.2245	5.717
62	1.3205	26.0866	19.7554	5.987
63	2.0060	35.5769	17.7354	9.573
64	1.6708	26.3397	15.7650	8.258
65	1.5716	21.7829	13.8600	7.692
66	2.0986	27.0524	12.8906	8.836
67	2.3760	28.3572	11.9348	10.821
68	2.4325	26.6869	10.9708	10.899
69	2.4723	26.8231	10.8495	11.659
70	2.2282	24.2262	10.8724	11.092
mean	1.7291	27.4294	17.3148	83.706

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Not to be qouted

EFFECTS ON THE VIET NAM WAR AND THE NORMALIZATION OF THE KOREAN-JAPANESE RELATIONS ON THE KOREAN ECONOMIC DEVELOPMENT IN 1960'S

Hak Chung Choo

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PREFACE

This paper is one in the series of continuing KDI research works which is designed to aid in the formulation of sound public policies and to promote public understanding of issues of the Korean economy.

This working paper is a preliminary report of our on-going research that will deal with so-called exogenous factors in economic development with special reference to the Korean economy during the 1960's. The final report will also include a theoretical formulation of economic development relating economic factors with non-economic factors in its modus operandi as well as the consideration of qualitative elements other than dealt in this working paper. Although this paper represents only a small fragment of our research efforts toward this direction, it serves as a point of departure toward the frame of reference mentioned above.

The interpretations and conclusions in this paper are those of the author and do not represent the views of the Korea Development Institute. Finally, I would like to extend my appreciation to those within and outside of this Institute who have participated these endeavours.

Mahn Je Kim
President

EFFECTS ON THE VIET NAM WAR AND THE NORMALIZATION OF THE KOREAN-JAPANESE RELATIONS ON THE KOREAN ECONOMIC DEVELOPMENT IN 1960'S*

by

Hak Chung Choo

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I. INTRODUCTION

The Korean economy had grown remarkably during the period of 1960's, especially in the later part of 1960's. Inspite of some of the critical and inherent problems resulted by such growth,[1] the planned targets of the First-Five Year Plan (hereafter referred as FFYP) were in general met by the actual achievements. So that the course of development had proven many harsh criticisms[2] against the FFYP and its revision unwarranted.[3] The main force behind this remarkable drive was, of course, the existence and successful implementation of the Five-Year Plans by the Government of Korea, that committed its leadership to economic development.[4] In addition, there were many so-called exogeneous factors,[5] fully unaccounted for and unexpected in the formulation of the plans, in the Korean economic reality, which had, in fact, reduced the plan targets as forecasts allowing some deviations due to these factors.

As early as in the 1960's, such factors as the Rostovian Preconditions, pervasiveness of educational facilities, strategical

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[1] Kim [22]

[2] IBRD [18], Little [26], and Waterson [38, p. 161]

[3] Kuznets [25, p. 49]

[4] Adelman [1, p. 1]

[5] For theoretical implications, see Svennilson [illegible, pp. 99-113]

geopolitical location, public confidence in government, etc., were recognized by many writers of the Korean economy,[6] without giving their fuller implications to the recent Korean development. During the middle of 1960's, there were, also, other such, often under-emphasized, factors as significantly large idle facilities,[7] the Korean involvement in the Viet Nam War and the political normalization of the Korean-Japanese relations. The existence of idle manufacturing facilities is considered significant for the reasons that it served to meet induced demands by the two international developments and contributed to fast growth during the later period of 1960's.[8]

The primary purpose of this study is to assess the effects of these two international political developments, effectively took place in 1966, on the Korean economic development during the later period of 1960's and on the actual achievements of the planned targets of the FYYP and SFYP. These two events were non-economic in their natures. However, the economic effects resulted from the two are measureable and diversified. The political development with Japan had primarily contributed to the inflows of capital, both public and commercial, in the forms of reparation, soft and commercial loans, and direct investment, to capital formation and to the expansion of export-

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[6] Kanesa-Thasan [20, pp. 273-275], Koide [24, pp. 37-38] and Wolf [39, p. 228]

[7] Economic Planning Board [14]

[8] The existence of such extensive idle capacities is the primary reason for unexpectedly low capital-output ratios in the succeeding years. See EPB [15]

import activities. The Korean involvement in Viet Nam War not only has political implications as to returning its indebtedness to the U.S. and its allies, but also, has relieved somewhat the foreign exchange bottleneck severly faced by Korea. In addition to favorable trade balances, military procurements and the foreign exchange remittances by the Korean troops and engineers in Viet Nam were sizable sums since 1966.

We will, first of all, examine the magnitudes of economic relations resulted from these two international events during the period of 1966-71. Then, the effects of the two events will be evaluated in three aspects: Effects on income and employment, on capital formation and on international trade and balance of payments. The analytical methods used in the study are primarily those of national income accounts broadly defined, including input-output, and capital formation balance of payments analyses.

II. THE MAGNITUDES OF ECONOMIC RELATIONS: AN OVERALL ASSESSMENT

As the results of the political normalization and the Korean involvement in the Viet Nam War, there were the inflows of capital from Japan and expanded trade activities with Japan and Viet Nam. The magnitudes of economic relations, i.e., capital inflows from Japan, trade with Japan and Viet Nam, and foreign exchange receipts from Viet Nam, are summarized in Table 1-3.

The inflows of capital from Japan, as shown in Table 1, began in 1966 according to the Treaty signed by the Governments of Korea

and Japan in 1965. The Japanese government agreed to pay $300 million for so-called properties and claims, to provide $200 million in soft loans and to encourage $300 million in commercial loans over a ten year period.[9] The execution of the PAC fund and public loans was carried out as agreed except for the inevitable time lags between the approvals and settlements. However, the inflow of commercial loans were very rapid and reaching its peak in 1968, amounting to the approval of $110 million for that year alone. Since then, the inflow of commercial loans has declined and gradually replaced by direct investments from 1969.

Expanded trade activities with Japan and Viet Nam are shown in Table 2. The Korean-Japanese trade relations have been always unfavorable as shown in Table 2. Inspite of tremendous efforts to expand the Korean exports during the 1960's, the exports to Japan has lagged behind the pace of its export expansion. Even after the political normalization, the trade deficit between the two accounted for about 50% of the entire Korean trade deficits. This ratio is extremely high even when the non-competitive imports from Japan[10] and the imports financed by both public and commercial loans are accounted for.

On the other hand, the relative importance of Japan as an export market for Korean in the World and in Asia continuously declined until

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[9] Bureau of Trade, the Ministry of Foreign Affairs [illegible], p. [illegible]

[10] The import components of non-competitive goods fluctuate from 15.4% to 25.9% of total imports from Japan during the period of 1966-71, since 1968, this ratio never exceeded 20%.

Table 1. Foreign Aids and Capital Inflows to Korea, 1966-71

Unit Value; in 1,000 U.S. dollars
Arrival Basis

Types	1966	1967	1968	1969	1970	1971	Total
Aids Funds	184.550	120,729	145,711	163,774	95,291	57,991	768,046
Japan	29,676	30,175	33,619	31,103	24,494	13,575	162,642
%	(16.08)	(24.99)	(23.07)	(18.99)	(25.70)	(23.52)	(21.18)
Official Loans	72,831	105,620	70,220	138,934	115,325	874,000	1,376,930
Japan	12,149	25,351	16,198	21,363	12,497	16,728	104,286
%	(16.68)	(24.00)	(23.07)	(15.38)	(10.84)	(1.91)	(7.57)
Commercial Loans	109,852	124,001	268,366	408,882	378,590	169,700	1,459,391
Japan	64,715	44,459	88,205	87,474	82,499	62,850	430,511
%	(58.91)	(35.85)	(32.87)	(21.46)	(21.79)	(37.04)	(29.50)
Direct Investment	2,104	20,923	31,799	42,936	85,807	558,851	742,420
Japan	-	1,374	8,241	23,021	21,798	22,375	77,169
%	-	(8.29)	(25.77)	(53.62)	(25.40)	(4.00)	(10.39)
Total	369,337	371,273	516,096	754,526	675,013	1,660,542	4,346,787
Japan	106,540	101,359	146,263	163,234	141,288	115,528	774,608
%	(28.85)	(27.30)	(28.34)	(21.63)	(20.93)	(6.96)	(17.82)

Sources: USAID, Summary of U.S. Economic Aid to Korea, (Seoul: 1972)
Economic Planning Board, the Republic of Korea

Table 2. Korean Exports to and Imports from Japan, 1960-71

Unit Value: In million U.S. dollars
Basis: Customs Clearance basis

	1960	1961	1962	1963	1964	1965	1966
Total Imports	343.5	316.1	421.8	560.3	404.4	463.4	716.4
Asian Imports	97.8	91.9	141.5	208.4	146.2	228.2	384.8
(as % of total imports)	(28.46)	(29.07)	(33.54)	(37.20)	(36.16)	(49.24)	(53.71)
Imports from Japan	70.4	69.2	109.1	159.3	110.1	166.6	293.8
(as % of total imports)	(20.49)	(21.89)	(25.88)	(28.44)	(27.2[illegible])	(35.96)	(41.01)
(as % of Asian imports)	(72.00)	(75.30)	(77.17)	(76.45)	(75.32)	(73.02)	(76.35)
Total Exports	32.8	40.9	54.8	86.8	119.1	175.1	250.3
Asian Exports	22.9	28.4	35.7	53.7	66.0	85.8	104.8
(as % of total exports)	(72.75)	(69.51)	(65.14)	(61.91)	(55.46)	(48.98)	(41.88)
Exports to Japan	20.2	19.4	23.5	24.8	38.2	44.0	66.3
(as % of total exports)	(61.46)	(47.45)	(42.84)	(28.62)	(32.05)	(25.12)	(26.48)
(as % of Asian exports)	(84.48)	(68.26)	(65.77)	(46.23)	(57.09)	(51.28)	(63.23)
Total Trade deficits	-310.7	-275.3	-367.0	-473.5	-285.3	-288.4	-466.1
Asian Trade deficits	- 74.9	- 63.5	-105.8	-154.7	- 80.2	-142.5	-280.8
(as % of total balances)	(24.11)	(23.07)	(28.82)	(32.67)	(28.10)	(49.40)	(60.07)
Trade deficits from Japan	- 50.2	- 49.8	- 85.7	-134.5	- 72.0	-122.7	-227.5
(as % of total balances)	(16.17)	(18.10)	(23.35)	(28.41)	(25.22)	(42.54)	(48.81)
(as % of Asian balances)	(67.06)	(78.45)	(81.01)	(86.95)	(89.76)	(86.11)	(81.26)

Sources: Office of Customs Administration, Statistical Yearbook of Trade, 1964-71
The Bank of Korea, External Trade Statistics for 1960-64

1967	1968	1969	1970	1971
996.2	1,462.9	1,823.6	1,984.0	2,394.3
573.6 (57.58)	824.5 (56.2)	1,027.2 (56.33)	1,127.9 (56.9)	1,352.8 (56.5)
443.0 (44.47) (77.23)	624.0 (42.5) (75.68)	753.9 (41.0) (73.39)	809.3 (40.8) (71.75)	953.8 (39.8) (70.50)
320.2	455.4	622.5	835.2	1,067.6
129.2 (40.33)	151.9 (33.3)	213.5 (34.3)	316.0 (37.8)	373.4 (35.0)
84.7 (26.46) (65.60)	99.7 (21.90) (65.65)	133.3 (21.42) (62.46)	234.3 (28.06) (74.15)	262.0 (24.54) (70.17)
-676.0	-1,007.5	-1,201.1	-1,148.8	-1,326.7
-444.5 (65.75)	-672.5 (66.76)	-813.7 (67.75)	-811.9 (70.67)	-979.4 (73.82)
-358.3 (53.00) (80.61)	-524.3 (52.04) (77.95)	-620.5 (51.66) (76.25)	-575.0 (50.05) (70.82)	-691.8 (52.14) (70.63)

1968 and has improved slightly since then. The Korean import dependency on Japan had marked the peak of 44.5% of all imports in 1967 and has reversed its trend somewhat since 1968.

Although the absolute size of trade volume is relatively small, the Korean-Viet Namese trade relationship is a contrast to that between Korea and Japan. As shown in Table 3, there were always export surpluses against Viet Nam. Existing trade surpluses are only small fragments of the favorable economic relationship that Korean has enjoyed since its involvement in the war. There were an army of engineers for both the Korean and U.S. contractors, a group of Korea businessmen catering to the military procurements and a few divisions of military staff sending their salaries and allowances to home. In 1966, the foreign exchange earnings from Viet Nam was 60.5 million dollars and grew very rapidly to 172.4 million in 1969. Since then, the foreign exchange earnings declined to $151.9 million and $124.9 million respectively in 1970 and 1971.

From the preceding examination of data, there emerges some significant differences in the characteristics of the two international developments. The political normalization has both positive and negative aspects of the economic consequences. Positively, the normalization has triggered the inflows of the foreign capital, both public and private, so desirable especially during the FFYP period. Especially, the PAC fund was timely to supplement the U.S. foreign aid cuts to Korean begun in 1964 and further reduced in 1966. On the negative side, the normalization flood the Korean market with imported Japanese goods accentrating the problem of balance-of-payments.

Table 3. Foreign Exchange Receipts from Viet-Nam, 1966-71

Unit Value; in U.S. 1,000 dollars

	1966	1967	1968	1969	1970	1971
Exports	13,900	5,700	3,818	11,920	13,426	14,300
Imports	-	50	413	422	247	282
Trade Balance	13,900	5,650	3,405	11,498	13,179	14,018
Military Procurement	22,445	54,676	79,838	74,925	70,109	56,000
Goods	(9,889)	(14,456)	(30,823)	(23,635)	(24,323)	(21,200)
Services	(8,142)	(32,685)	(40,083)	(46,800)	(38,399)	(26,500)
Construction	(4,414)	(7,535)	(8,932)	(4,490)	(7,387)	(8,300)
Remittance by Engineers	9,063	34,335	33,250	43,108	26,909	15,300
Remittance by Military Staff	13,164	29,950	34,559	31,522	26,206	24,700
Special L/C	1,915	8,800	4,600	10,900	15,200	13,900
Sales of PX Coupons	-	-	-	-	-	7,100
Total	60,487	133,411	155,652	171,973	151,603	124,618

Source The Bank of Korea

The economic consequences of the Viet Nam War were all favorable. The most noteworthy is that it served to relieve the foreign exchange bottleneck constantly threatening the Korean economy.

III. EFFECTS ON THE KOREAN ECONOMIC DEVELOPMENT

The economic consequences of the preceding two international developments and their effects on the Korean economy during the later part of 1960's have been far reaching. Of these, we will consider three major aspects. First, the expanded tangible and intangible exports to Japan and Viet Nam and the remittances by the military staff and engineers in Viet Nam had contributed in generating significant amounts of final demands in these years. Such increases in final demands would have, in turn, affected income, employment and growth during the period under consideration. Secondly, the normalization of the Korean-Japanese relations have induced, as examined, the inflows of Japanese capital, both public and private, and economic cooperations by the two countries. Consequently, the political normalization of the two has contributed to capital formation, vis-a-vis foreign savings, and in achieving the goals of capital formation and foreign capital inducement in the five-year plans. Lastly, the expanded trade activities with Japan has affected negatively the balance of payments position of Korea during the period under consideration. On the other hand, the economic relations resulting from the Korean involvement in Viet Nam has relieved this pressure somewhat with the foreign exchange earnings. These effects will be examined within the context

of the Korean development in the late 1960's and the framework of the five-year plans.

Because of the inherent limitations of Economics as a science and available data, that is, the impossibility of conducting a controlled experiment, it is extremely difficult to assess accurately the resulting impacts of the two international events. What we propose to do is to compare the resulted effects with aggregate data of the Korean economy as an approximation. In seperating the effects that we are concerned, we will attempt to do so from the totality composed of the resultants of all factors. The defect here is the inability to measure what would happen without the two developments of our concern and to seperate the interactions between the other implicit and the two explicit factors. Of course, the following analysis is subject to these limitations.

1. Income and Employment Effects.

Using the Korean input-output tables of 1966 and 1968, the income and employment effects of the normalization and the Viet Nam War are measured. The models applied here are more or less widely used in assessing such impacts. Given with the inverse and quasi-inverse matrices of domestic inputs, $A^v (1-A^d)^{-1}$ and $L (1-A^d)^{-1}$, income and employment effects are measured as follows:

$$GNP_t = A^v (1 - A^d)^{-1} Y_t^e ,$$

$$N_t = L (1 - A^d)^{-1} Y_t^e ,$$

where GNP_t = Gross National Product of Year t ,

N_t = employment of year t ,

A^v = the vector of value added ratios,

A^d = inputs of domestic origins ,

L = labor coefficient of 1968 ,

and Y^e = final demand of year t .

The final demand matrix, Y^e_t, is composed of exports to Japan and Viet Nam, the military procurement sales by sectors, and transfers of income by the remittances of engineers and military staff serving in Viet Nam. All except the disposition of remittances were easily estimated by sector by tedious aggregations of export data by SITC classification into I-O sectoral classification.

Income and employment effects from the War are underestimated to an unknown degree, due to the treatments of data. For one thing, the sizes of wage bills to both the military staff and engineers are unknown. The only available figures are the remittances by them. How much foreign exchange they had received and brought back may be anyone's guess. Another problem faced in assessing the impacts was the question of how to deal with the sales of military procurements of construction and services. Construction services would have been rendered in Viet Nam by Korean contracters using materials and labor inputs, locally procured and/or supplied by imports from Korea. How would the proceeds from these services would affect the Korean economy, specifically its income and employment? And material inputs been imported from Korea, they would been recorded in export statistics. If the Korean engineers are employed, their portion of income affecting the Korean economy would been transmitted to Korea. For these reasons and difficulties, the final demand matrix excludes the military procurements of construction and services in Viet Nam.

In estimating sectoral consumption expenditures from the remittances by military staff and engineers, the ratios of private consumption by sector of the input-output Tables, 1966 and 1968, are the basis of the estimation of consumption expenditures rather than the consumption expenditures of urban and rural households for two reasons. First, there exists the problem of matching the expenditure items of household consumption with the 43-sector classifications of the input-output table, i.e., a familiar problem of disaggregation. Secondly, it was extremely hazardous to as sign the weights to urban and rural households since there were no available records as to the data on regional distribution of remittance recipients. Instead of introducing more assumptions for disaggregating and weighting different statistical series, the total remittances less than average savings of households were divided according to private consumption patterns reflected in the Korean input-output tables of 1966 and 1968.

The results of computations are summarized in Tables 4 and 6. As shown in Table 4, the income effects of expanded export activities had constantly increased from 9.7 billion won in 1965 to 40.3 billion won in 1970. The increases in contributions to GNP by the Viet Nam War are far more impressive. In 1965, it was only 2.1 billion won, increased to 23.9 billion won in 1969, and slightly decreased to 22.5 billion won in 1970. Their shares to GNP were 1.5% and 2.2% in 1965 and 1966 respectively. But for the period 1967-69, it was approxi-

mately 3.7% but in 1970, it reached to 4.4%.[11]

To evaluate the significance of the contributions of the two international developments to the growth of the Korean economy during the corresponding period, the growth rates are adjusted by subtracting the contributions of the primary sector that are randomly influnced primarily by weather and other conditions. As shown in Table 5, the contributions of the Viet Nam War and the political normalization are far more than marginal. In fact, one third to half of the adjusted growth rates is accounted for by the two international events. Therefore, it is not a mere coincidence to find the diffusion index by the moving index of months for cyclical dominance picking up from the early 1965 and declining from the middle of 1970.[12] In another words, a spectacular growth of the Korean economy during the later part of 1960's and the business set-back in 1970 may be significantly attributable to the economic consequences of the two non-economic factors.

The effects on employment using the input-output data are summarized in Table 6. In 1965, the exports to Japan and Viet Nam provided jobs to some 79.7 thousand workers. As the remittances by engineers and military staff and the military procurements began to taken place, the employment effects accelerated providing jobs to some 453.6 thousand workers in 1970. In view of total employment data for

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[11] A Study by a group of economists at Seoul National University indicates that the impact of the Viet Nam Special Procurement on the Korean economy was 1% to 3.3% during the period of 1965-69. This analysis is based on a simple ratio of the dollar amount of special procurement to the GNP in dollars for each year, implying an inconsistency of comparing the sales against the value added.
See Seoul National University [35, p. 88]

[12] The Bank of Korea [7], Kim [21]

Table 4. Income Effects

In 1965 Constant Billion Won

Income Effects	1965	1966	1967	1968	1969	1970	1971
From Exports to Japan	9.7	13.3	17.0	19.4	24.1	40.3	41.0
As % of GNP	(1.21)	(1.46)	(1.71)	(1.72)	(1.84)	(2.83)	(2.62)
From Exports to Viet Nam	2.1	2.2	1.3	1.1	2.6	2.6	2.0
As % of GNP	(0.26)	(0.24)	(0.13)	(0.1)	(0.20)	(0.18)	(0.17)
From Military Commodity Procurements	-	1.8	2.7	6.5	5.5	8.3	-
As % of GNP	-	(0.2)	(0.27)	(0.58)	(0.42)	(0.58)	-
From Remittances from Viet Nam	-	4.9	14.8	15.3	15.8	11.6	-
As % of GNP	-	(0.54)	(1.44)	(1.36)	(1.21)	(0.82)	-
Total	11.7	22.3	35.9	42.2	48.1	62.8	43.6
As % of GNP	(1.45)	(2.44)	(3.61)	(3.74)	(3.68)	(4.42)	(2.78)

Table 5. Growth Rate and Contributions of the Normalization and the War

	1965		1966		1967		1968		1969		1970		1971	
	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual
GNP Growth Rate	7.8	7.4	8.3	13.4	7.0	8.9	7.0	13.3	7.0	15.9	7.0	8.9	7.0	10.2[p]
Contribution of the Primary Sector	2.0	-0.3	2.2	4.2	1.8	-1.8	1.8	0.4	1.8	3.4	1.7	-0.2	1.7	0.6
Adjusted Growth Rate	5.8	7.7	6.1	9.2	5.2	10.7	5.2	12.9	5.2	12.5	5.3	9.1	5.3	9.6
Contributions of the Two Events		1.5		2.4		3.6		3.7		3.7		4.4		2.6
Net Growth Rate		6.2		6.8		7.1		9.2		8.8		4.7		6.6

p: Preliminary

Sources: Economic Planning Board, The First Five-year Economic Development Plan, 1962-66, (Seoul: 1961)
The Second Five-year Economic Development Plan, 1967-71, (Seoul: 1966)
The Bank of Korea, National Income Statistics Yearbook, 1971. (Seoul: 1971)

Table 6. Employment Effects

Unit: 1,000 men/year

Employment Effects	1965	1966	1967	1968	1969	1970	1971
From Exports to Japan	70.7	98.3	117.5	139.4	170.4	283.0	285.6
From Exports to Viet Nam	9.0	10.5	7.1	6.0	13.7	12.1	16.4
From Military Commodity Procurement	-	10.2	15.7	45.7	42.6	55.0	-
From Remittances from Viet Nam	-	46.4	139.8	136.4	141.2	103.5	-
Total	79.7	165.4	280.1	327.5	367.9	453.6	302.0
Total Employment	8,522	8,659	8,914	9,261	9,347	9,574	9,708
Annual Increment	312	137	255	347	86	227	134

corresponding years, the employment effects seem to be somewhat overestimated since the average labor coefficients were used for computations.[13] There may be a difference in the marginal and average labor coefficients and consequently a difference in the marginal and average labor-output ratios. If the increased export and consumption demands were probably met by the marginal increments of productive facilities and inputs, the resulting employment would be far less than the employment requirements computed by using the average labor coefficients. Nontheless, it is safe to infer that the final demands created by the Viet Nam War and the normalization of political relations had significantly contributed to fuller employment during this period.

2. Effects on Capital Formation

Since the normalization, capital inflows and direct investments from Japan amounted to sizable volumes. As examined earlier,[14] Japanese commercial loans and direct investment made to Korea from 1966 to 1971 amounted to 430.5 and 77.2 million dollars respectively, in additions to 162.6 million dollars in PAC funds and 104.3 million dollars in official loans. The shares of the Japanese PAC funds, public and private loans and direct investment are approximately 21%, 7%, 29% and 10% respectively during the period of 1966-71. Considering the fact that foreign aids, loans and direct investments had financed about 41.8% of gross domestic capital formation during the period of 1965-70, it is probable to infer from Table 7 that Japanese capital inflows had

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[13] The Bank of Korea [3, p. 39]

[14] See Table 1 in page of this Paper.

Table 7. Capital Importation from Japan, 1965-71

Unit Value: In 1965 constant billion won

Year	Importation of machinery and transport equipment from Japan (1)	Importation of machinery and transport equipment with PAC funds (2)	Investment on machinery and transport equipment (3)	Gross domestic capital formation (4)	(1)/(3) (5)	(2)/(3) (6)	(1)/(4) (7)
1965	6.81	-	38.02	117.64	17.91(%)	-	5.79(%)
1966	20.40	0.95	88.38	190.63	23.08	1.07(%)	10.70
1967	33.83	4.18	114.90	232.09	29.44	3.64	14.58
1968	55.97	3.44	157.93	325.63	35.44	2.18	17.19
1969	65.55	4.62	184.22	407.76	35.58	2.51	16.08
1970	61.94	3.47	175.07	416.76	35.38	1.98	14.86
1971	65.11	3.46	207.50p	438.54p	31.38	1.67	14.85

p: Preliminary

Sources: The Bank of Korea, National Income Statistics Yearbook, 1971 (Seoul: 1971),
The Bank of Korea, Monthly Statistical Review, May, 1972,
Office of Customs Administration, Statistical Yearbook of Foreign Trade, 1965-71.

contributed about 25% of the foreign saving or 10% of gross domestic capital formation.

Furthermore, according to the KDI estimates based on the Japanese import data, machinery, transport and other equipment classified as capital goods by the Bank of Korea[15] accounted for 17.9% and 35.4% of all transport and machinery portion of capital formation in 1965 and 1970 respectively. Of these, the portion of machinery and transport equipment financed by PAC funds are also shown in Table 7. The seperation of investment in machinery and transport equipment from other components of gross domestic capital formation is attempted here to optimize its importance as the addition to productive facilities in the narrow sense.[16] One thing to note with regards to these estimates of capital goods is the fact that these figures do not include necessary installation costs and accompanying investments usually added in estimating capital formation. The rates of installation and accompanying investments range from 100% to 280%. Therefore, the reduction in capital formation would be far greater than the import figures of machinery and transport equipment without which accompanying installation investment with domestic resources would not be materialized.

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[15] The Bank of Korea [9]

[16] Often the rate of gross domestic capital formation to GNP especially in the context of the Korean experiences is sometimes misleading in the sense that such items as the charge in inventory and housing construction in GDCF do not constitute productive fixed capital. As compared to Japan, the portion of housing construction in the Korean data in 1960's is substantially high.

Another interesting aspect to note is that imports from Japan financed by KFX fund are primarily raw and intermediate materials. Imports financed by other than the KFX fund more or less corresponds to the amounts of capital goods importation from Japan. In retrospect, had there not been the inflows of capital from Japan, actual underachievements of foreign capital inducement and consequently capital formation would have been far more severe than the accomplishment. The successful implementation of FFYP was, of course, the primary attraction and motivation for foreign leaders and investors to come into Korea during the SFYP. Because of such capital inflows coupled with those from Japan, foreign savings for the SFYP far exceeded than the planned amount in contrast to that for the FFYP.[17]

Of course, there are other good and bad consequences of foreign capital inflows and investment such as import substitution, externalities of learning by doing, borrowing of new technology and knowhow, problem of debt service and repayment and mismanagement and bankruptcy of firms financed by foreign capital, among others.[18] However, these aspects are recognized but are beyond the scope of this study, at least at this stage of this on-going research.

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[17] Professorial Evaluation Team [30, p. 65; 31, p.37; 32, p. 30; 33, p.9; 29, p.9]

[18] See an interesting study on these aspects by the Research Institute of Trade: Im and others [19]

3. On International Trade and Balance of Payments

Korea being one of the most densely populated countries in the world and being a resource scarce country, the import dependancy rate is consequently high. As examined in Table 2, there was, on the one hand, a remarkable growth in Korean exports during 1960's surpassing the targets set in FFYP and SFYP. But, on the other hand, imports grew too, but not as fast as exports. The result of these was structual disequilibrium at factor level, i.e., the foreign exchange bottle-neck,[19] quite common in developing countries.

Some of the increasing imports are, of course, the results of foreign capital inflow and investment took place in Korea since 1966 and the importation of raw and semi-processed materials for export goods including those for the exports to both Japan and Viet Nam. However, the exports to Japan and Viet Nam have contributed to foreign exchange earning as much as the income resulted from them,[20] if not more in the case of remittance by engineers and military staff.

As seen in Table 3, Korea has certainly enjoyed favorable balance of payment against Viet Nam. Therefore, foreign exchange earnings from both tangible and intangible exports from Viet Nam certainly have relieved the pressure of current deficits of balance of payment as reflected in Table 8. In contrast to the situation with Viet Nam,

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[19] Kindlebuger and E. Depres [23]

[20] Since the foreign exchange earning is the amount of export less that of imported inputs.
Algebraically,

$$FX = Y^e - A^m(I-A^d)^{-1} Y^e$$
$$= I - A^m(I-A^d)^{-1} Y^e$$
$$= A^v(I-A^d)^{-1} Y^e$$

Table 8. Analysis of Balance of Payments, 1964-70

Unit Value: In million U.S. dollars

	1964		1965		1966	
	Total	Japan	Total	Japan	Total	Japan
Goods						
Exports(F.O.B)	119.1	38.2(32.1)	175.1	44.0(25.1)	250.3	65.5(26.2)
Imports(F.O.B)	-364.9	-104.5(28.6)	-420.3	-153.0(36.4)	-679.9	-306.5(45.1)
Nonmonetary gold	0.9	-	0.5	-	0.1	-
Trade Balance	-244.9	- 71.7(29.3)	-244.7	-109.0(44.5)	-429.5	-241.0(56.1)
Services & Private Transfer						
Receipts						
Government services	75.7	0.1(0.1)	88.1	0.1(0.1)	136.5	0.4(0.3)
(military services)	63.7		74.0		114.1	
Other services	15.3	2.7(50.9)	26.1	3.2(12.3)	67.8	11.9(17.6)
Transfer	56.7	16.4(28.9)	74.0	13.6(18.4)	103.3	18.5(17.9)
Payments						
Freight & insurance	-38.4	-4.2(10.9)	-43.1	-9.6(22.3)	-57.4	-12.7(22.1)
Other services	-28.7	-2.2(7.7)	-25.0	-2.4(9.6)	-40.4	-8.1(20.0)
Transfer	-3.7	-0.6(16.2)	-6.9	-1.9(27.5)	-7.7	-4.3(55.8)
Net	76.9	12.2(15.9)	113.2	3.0(2.7)	202.1	5.7(2.8)
Balance of Payments	-168.0	-59.5(35.4)	-132.0	-106.0(80.3)	-227.4	-235.3(103.5)

(Continued)

1967 Total	1967 Japan	1968 Total	1968 Japan	1969 Total	1969 Japan	1970 Total	1970 Japan
334.7	84.7(25.3)	486.2	99.7(20.5)	658.5	140.1(21.3)	882.2	245.2(27.8)
-908.9	-420.5(46.3)	-1,322.0	-547.1(41.4)	-1,650.0	-684.0(41.5)	-1,804.2	-736.3(40.8)
-	-	0.1	-	-	-	-	-
-574.2	-335.8(58.5)	-835.7	-447.4(53.5)	-991.7	-543.9(54.8)	-922.0	-491.1(53.3)
208.9	0.4(0.2)	257.4	2.3(0.9)	299.1	5.6(1.9)	279.9	1.4(0.5)
171.4		216.6		249.4		232.2	
99.3	8.3(8.4)	136.6	27.2(19.9)	193.3	29.7(15.4)	216.9	41.5(19.1)
101.9	14.0(13.7)	117.8	18.7(15.9)	169.8	28.0(16.5)	118.6	22.4(18.9)
-71.6	-28.7(40.1)	-104.6	-40.9(39.1)	-133.3	-56.7(42.5)	-157.9	-68.8(43.6)
-79.5	-11.7(14.7)	-120.1	-19.9(16.6)	-161.8	-32.3(20.0)	-219.6	-35.3(16.1)
-13.2	-2.9(22.0)	-14.7	-6.7(45.6)	-32.5	-7.6(23.4)	-25.0	-14.6(58.4)
245.8	-20.6(8.4)	272.4	19.3(7.1)	334.6	-33.3(10.0)	212.9	-53.4(25.1)
-328.4	-356.4(108.5)	-563.3	-428.1(75.0)	-657.1	-577.2(87.8)	-709.1	-544.5(76.8)

( ): As % of Japan to Total

Sources: The Bank of Korea, Economic Statistics Yearbook, 1965-71, (Seoul: 1965-71)
Research Department, the Bank of Korea, Analysis of Balance of Payment against Japan, 1964-70, (unpublished working table)

it is noticable in the same table that the problem of the Korean balance of payments stems mainly from its relations with Japan. The current deficits against Japan for 1966 and 1967 exceeded the total deficits for these years. Even in the succeeding years, about 76 to 88 percent of the total deficits is attributable to Japan. Indeed, it is the most undesirable effect of the political normalization of Korean-Japanese relations.

Based on the preceding analysis, it is safe to argue that the best ways to relieve and to surmount the problem of balance of payments are to promote the import-substitute industries for commodities being imported from Japan and/or to expand both tangible and intangible exports to Japan. For the former remedy, vertical interindustrial restructuring of the economy and build-up of basic and key industries should precede to reduce foreign exchange requirements. For the latter, the initiative of the Japanese government to reduce import restrictions of commodities being produced by developing countries like Korea. For example, her share of the Japanese import market had gradually increased from 0.5% in 1965 to 1.3% in 1971, as compared to the Japanese share of exports to Korea, 1.7% in 1964 to 4.0% in 1971.

The Japanese government and its advisors are inclined to such changes in Japanese trade policies.[21] Yet, there has been little implementation to narrow the existing gap between the wide road from and the narrow one to Japan in international trade. Granted there are many problems in promoting exports to developed countries to be resolved

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[21] Bureau of Trade Promotion the Ministry of International Trade and Industries [12, p. 210].

by the efforts of developing countries,[22] however, developed countries should take the initiative and be more sympathetic forward these problems.

IV. SUMMARY AND CONCLUSIONS

It seems that the economic consequences of the two political developments in the middle of 1960's, i.e., the political normalization of the Korean-Japanese relations and the Korean involvement in the Viet Nam War, are quite significant in terms of their effects on income, employment, growth, capital formation and balance of payment of the Korean economy during the later half of 1960's. Had it not been for such favorable developments and resulted economic consequences, the Korean economy would not have achieved the growth rates so high during this period and consequently some of the goals of the five-year plans. Based on the use of the open input-output model given with the final demand matrices, about 1.5% to 4.4% of the growth rates during the period of 1965-71 could be explained by the income effects of the two international events. Of course, these findings are subject to the assumptions and analytical restrictions of the methods employed in this study.

Economic consequences of the Viet Nam War to Korea were all favorable in all related aspects. However, there were both favorable and unfavorable consequences resulting from the normalization. Japanese capital inflows and investment had significantly contributed to capital formation during this period. While the trade relations

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[22] Ibid [13, pp. 209-212]

with Japan further accentuated the deterioration of Korean balance of payment problem. The major cause of this deterioration is the gap between the low share of Korean exports to Japanese import and the high share of Japanese export to Korean import. Therefore, the short-cut to revolve the balance of payment problem constantly haunting the Korean economy is to achieve the break-even point or at least to narrow the existing gap between the Japanese import from and export to Korea.

The induced final demands resulted from the two international development fueled the fast expansion of the Korean economy during this period, coupled with the foreign capital inflows and investment into Korea. Consequently, the Korean economy has borne the social costs of rapid expansion manifested in such problems as misallocation of resources, business contraction, mismanagement, debt service and repayment and others in recent years. What need to be realized are the contributing factors to growth others than economic factors usually dealt in the literature of economic development, especially in the case of development of geographically small countries highly sensitive to and dependant on external relations, like Korea.

Whether or not the magnitudes of economic relations resulted from these events would sustain in the future is more of a political question rather than economic. It is probable that the economic impacts from the Viet Nam War will dwindle rather rapidly considering the current political environment in the U.S. It is also evident that the Japanese PAC fund and public loan amounting to $50 million per year will be terminated by 1975. Besides, Japanese businessmen

are attracted to joint-venture investment in Korea rather than lending commercial loans in recent years. And, inspite of the continuing threat of evaluation, the Japanese government does not seem to move fast enough to relax the import restrictions imposed on its imports from developing countries, at least, within foreseeable future. To surmount the difficulties faced by the Korean economy today and to sustain a rapid rate of growth and fuller employment, efforts should be made in all possible directions mentioned above, including the discovery of new "exogenous" factors of growth.

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TAX-CUM-SUBSIDY FOR EFFICIENT ALLOCATION OF RESOURCES

Wontack Hong

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PREFACE

This paper is one in the series of continuing KDI research works which is designed to aid in the formulation of sound public policies and to promote public understanding of issues of the Korean economy.

The main purpose of this research project is to measure the "optimum" subsidy for each industry with the ultimate objective of achieving efficient resource allocation which will "maximize the national income stream". The research project will be carried out in several stages, starting with the investigation of all possible methods to measure an optimum set of taxes and subsidies and simple firsthand calculations of their magnitudes. This paper is the summary report of this first stage. It is to provoke constructive criticisms and suggestions and to solicit better ideas to approach the tax-cum-subsidy problem.

The interpretations and conclusions in this paper are those of the author and do not represent the views of the Korea Development Institute. Finally, I would like to extend my appreciation to those within and outside of this Institute who have participated in these endeavours.

Mahn Je Kim
President

TAX-CUM-SUBSIDY FOR EFFICIENT ALLOCATION OF RESOURCES

by Wontack Hong

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I. INTRODUCTION

With underemployment, resources can be put to a new use with little or no sacrifice of existing production. But the problem of allocation is more frequently a problem of increasing one type of production at the sacrifice of another type. The shift should be made if the increased output is valued more by users than that which is sacrificed. The relative prices and profit opportunities will usually cause the shift to be made, but the free market mechanism fails to achieve the efficient allocation of resources in several cases such as factor market imperfection, externalities, economies of scale and monopoly. Hence we face the question of the means by which, as well as the degree to which, the government should intervene in the market mechanism of resource allocation.[1]

Under a non-communist regime, the tax-subsidy system is practically the most important means available to the government to correct

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[1] Among the economic goals of a society is more future consumption as well as more present consumption. The problem of giving relative weight to the two goals, and optimally allocating resources between production for current use and investment is not so easy to solve. In this paper, we will simplify our problem by assuming exogenously determined propensities to save. Further, we will assume that ideal Keynesian fiscal and monetary policies are successfully implemented.

the free market mechanism and to achieve the equalization of the social marginal productivities of each factor of production throughout the economy. By setting taxes and subsidies, the government can enforce the efficient allocation of resources without promulgating production directives.

The main purposes of this research project are (1) to develop theoretical formulations to measure "optimum" subsidies for each trading industry, with the ultimate objective of achieving efficient resource allocations which will "maximize the national income stream"; (2) to examine the empirical results of the established theoretical formulations for Korea, Taiwan, Japan, etc.; and then (3) to provide some concrete and workable guidelines for the government tax-cum-subsidy policies. Emphasis will be focussed on the dynamic comparative advantage and the realization of an optimum trade pattern through tax-cum-subsidy.

Four different approaches have been adopted. (1) A historical approach (learning from one's and someone elses's experiences); which analyzes the effectiveness of a country's past tax-cum-subsidy policies on each trading industry and their impacts on overall economic growth. With proper modifications, this approach might give the most concrete and workable figures for the future government tax-cum-subsidy policies. (2) A short-run general equilibrium approach using input-output relationships; which is a local method of calculating the impacts of "small" changes in government tax-cum-subsidy policies on resource allocations, factor and commodity prices, trade patterns and national income. This approach is based on L. Taylor's model [10]. (3) A programming approach for optimum tax-cum-subsidy; which is a general equilibrium programming

model for shadow prices of externalities and primary inputs fashioned after the models of L. Westphal [11] and A. Manne & D. Keesing [6].
(4) Partial equilibrium approaches; which are to develop several useful tax-cum-subsidy schemes for efficient allocation of resources on the basis of intuition and simple partial equilibrium calculations.

The idealized pure tax-cum-subsidy scheme in our paper is understood as the following: a government with a distortion-free fiscal system (based on lump-sum taxes) raises a surplus of revenues over expenditures (the subsidy fund); it pays out a uniform ad valorem subsidy of a certain percentage on the production of externalities, or the purchase of an output or a factor by all users--the effective price that users or producers "see" then changes by approximately the same percentage--; and the revenue collected from a negative subsidy (tax) is added to the total subsidy fund. We are not concerned with public goods.

Our research project will be carried out in several stages, starting with the investigation of all possible methods to measure an optimum set of taxes and subsidies and simple firsthand calculations of their magnitudes. This paper is the summary report of this first stage. It is to provoke constructive criticism and suggestions and to solicit better ideas to approach the tax-cum-subsidy problem. Theoretically and empirically, this paper will be the starting point of more rigorous analysis for our research project.

II. HISTORICAL APPROACH FOR TAX-CUM-SUBSIDY: LEARNING FROM ONE'S OWN AND SOMEONE ELSE'S EXPERIENCES

An examination of the history of industrialization might throw light on the optimum magnitude of subsidies. Of course what has actually happened can never yield a conclusive answer to the question of what would have been the best. For instance, one may show that industrialization in some countries proceeded apace without much subsidies to, say, heavy industries. But it might have been better still for the country to have given more subsidies to the heavy industries, for the industrialization might have come earlier and the growth have also proceeded fast with heavy subsidies is no more conclusive. It might have been more efficient, and gone still faster with less subsidies.

With the above argument in mind, we may select a country which seems to have been developing successfully in terms of national income growth rate, say, Japan. And then, we may examine its past tax-cum-subsidy policies on trading industries, and examine the performance of the economy as a whole. Excluding the apparent failure cases, we may assume that the government of the country, say, the Japanese government, has accurately measured the magnitude of external economies of each production process as well as the shadow prices of primary factors, and carried out the optimum subsidy policies successfully. In a sense, it is an outrageous assumption. But this approach might give the most concrete and workable numbers and figures for the actual government tax-cum-subsidy policies, and with

the proper modifications, this approach might turn out to be the best form of "learning from someone else's experiences."

For "learning from one's own experiences", we will have to examine the allocation of subsidy funds in Korea during the 1955-1972 period and analyze the effectiveness of such subsidy policies on sectoral as well as aggregate growth rates of outputs, exports and imports.

Since we have not started this historical analysis for tax-cum-subsidy yet, we will simply present a summary Table of sectoral taxes, subsidies (bank loans), imports, exports and outputs for Korea. (Table 1.1)

We singled out bank loans to represent government subsidies because of (i) the inefficient capital market, (ii) the high usury rates, (iii) the application of special low rates of bank interest to large number of selected industries, (iv) the distribution of large amount of government loan funds through government operated banks such as the Korea Development Bank, the Medium Industry Bank, the Korea Housing Bank, etc., (v) the almost complete government control of every banking institution in Korea, and (vi) the fact that, apart from the direct government and foreign investments, bank loans constitute the essential form of subsidy funds given to private sectors in Korea.

Total amount of bank loans in Korea amounted to 35% of total value added in 1970, ranging from 11% in agriculture to 72% in manufacturing. Total amount of taxes (excluding personal income taxes) amounted to 10% of total value added, ranging from 2% in agriculture

and fishery to 14% in manufacturing. Total amount of tariff collected was about 8% of total import value of 1970, tariff rates varying from 2% in agriculture to 11% in manufacturing and 59% in fishery.

We can easily see that there have been wide range of sectoral variations in the rate of bank loans, taxes, tariffs and in the growth rates of sectoral value added, exports and imports. In order to examine whether we can find any easily identifiable associations between changes in tax-subsidies and changes [illegible]-trade performances, we made a series of Spearman's rank correlation tests.

As shown in Table 1.2 we could observe positive correlations between sectoral changes in value added, gross outputs (significant), and exports (significant) on the one hand and the sectoral changes in bank loans on the other. (All changes in terms of percentage change in total current dollar values.) We could also observe negative correlation between sectoral changes in imports and bank loans. The sectoral increases in taxes seem to be higher the faster the sectoral rate of increases in value added (significant), outputs, exports, and of decrease in imports. We could also observe negative correlation between the sectoral rate of changes in imports and the amount of tariffs collected. Although the observed relationships do not contradict common sense expectations, they are still too crude to be a basis for us to develop any kind of convincing arguments.

TABLE 1.1

SECTORAL TAX, SUBSIDY (BANK LOANS), IMPORTS, EXPORTS AND OUTPUTS

million dollars

Sector	1964	Change(%)	1967	Change(%)	1970
All Industries					
Value Added	2,796	42%	3,966	67%	6,626
Bank Loans/VA	0.13	119%	0.20	119%	0.35
Taxes/VA			0.07	32%	0.10
Import Tariff/Imports			0.08	85%	0.08
Gross Output	4,408	61%	7,074	70%	12,024
Imports/GO	0.09	147%	0.14	99%	0.17
Exports/GO	0.03	188%	0.05	161%	0.07
Agriculture					
Value Added	1,321	- 3%	1,277	44%	1,833
Bank Loans/VA	0.06	25%	0.07	128%	0.11
Taxes/VA			0.02	6%	0.02
Import Tariff/Imports			0.06	- 7%	0.02
Gross Output	1,548	4%	1,611	41%	2,269
Imports/GO	0.08	170%	0.12	135%	0.21
Exports/GO	0.01	70%	0.01	122%	0.01
Fishery					
Value Added	41	104%	83	54%	127
Bank Loans/VA	0.12	142%	0.14	124%	0.21
Taxes/VA			0.02	51%	0.02
Import Tariff/Imports			0.10	195%	0.59
Gross Output	58	106%	118	52%	180
Imports/GO	0.00	2,219%	0.02	-51%	0.01
Exports/GO	0.08	198%	0.12	7%	0.08
Mining					
Value Added	53	36%	71	17%	83
Bank Loans/VA	0.20	137%	0.36	117%	0.66
Taxes/VA			0.03	57%	0.03
Import Tariff/Imports			0.02	587%	0.04
Gross Output	87	54%	135	24%	166
Imports/GO	0.21	173%	0.37	215%	0.93
Exports/GO	0.23	44%	0.21	53%	0.27
All Manufacturing					
Value Added	462	70%	783	93%	1,508
Bank Loans/VA	0.30	163%	0.47	193%	0.72
Taxes/VA			0.16	68%	0.14

TABLE 1.1 (Continued)

Sector	1964	Change(%)	1967	Change(%)	1970
Import Tariff/Imports			0.10	96%	0.11
Gross Output	1,406	88%	2,637	73%	4,569
Imports/GO	0.18	178%	0.27	80%	0.28
Exports/GO	0.06	238%	0.10	182%	0.16
Food & Kindred					
Value Added	143	35%	193	101%	387
Bank Loans/VA	0.12	151%	0.23	176%	0.32
Taxes/VA			0.31	96%	0.30
Tariff/Imports			0.17	91%	0.11
Gross Output	399	73%	692	82%	1,258
Imports/GO	0.04	47%	0.03	198%	0.06
Exports/GO	0.05	39%	0.04	84%	0.04
Textiles					
Value Added	117	95%	228	13%	257
Bank Loans/VA	0.28	178%	0.40	174%	0.97
Taxes/VA			0.06	68%	0.09
Tariff/Imports			0.06	- 14%	0.02
Gross Output	362	105%	743	62%	1,201
Imports/GO	0.04	244%	0.06	117%	0.09
Exports/GO	0.07	388%	0.17	163%	0.28
Wood & Furniture					
Value Added	20	29%	26	106%	54
Bank Loans/VA	0.29	186%	0.64	265%	1.13
Taxes/VA			0.13	-192%	-0.06
Tariff/Imports			0.07	155%	0.11
Gross Ouput	65	72%	112	62%	181
Imports/GO	0.01	443%	0.02	55%	0.02
Exports/GO	0.18	241%	0.36	143%	0.53
Paper & Printing					
Value Added	32	76%	56	36%	76
Bank Loans/VA	0.35	109%	0.41	162%	0.80
Taxes			0.13	-49%	0.05
Tariff/Imports			0.09	-68%	0.07
Gross Output	82	79%	146	43%	208
Imports/GO	0.14	95%	0.15	116%	0.26
Exports/GO	0.00	1,245%	0.02	80%	0.02

TABLE 1.1 (Continued)

Sector	1964	Change(%)	1967	Change(%)	1970
Chemicals					
Value Added	59	57%	93	256%	332
Bank Loans/VA	0.52	162%	0.87	196%	0.72
Taxes			0.16	157%	0.11
Tariff/Imports			0.17	39%	0.17
Gross Output	221	61%	355	89%	671
Imports/GO	0.55	63%	0.56	45%	0.43
Exports/GO	0.01	544%	0.03	272%	0.06
Non-Metallic Mineral					
Value Added	23	78%	41	119%	90
Bank Loans/VA	0.48	103%	0.55	123%	0.56
Taxes/VA			0.15	7%	0.08
Tariff/Imports			0.06	269%	0.22
Gross Output	55	82%	100	95%	195
Imports/GO	0.05	457%	0.15	- 8%	0.07
Exports/GO	0.04	-47%	0.01	544%	0.03
Basic Metals					
Value Added	15	75%	27	123%	60
Bank Loans/VA	0.37	127%	0.48	288%	0.84
Taxes/VA			0.17	-84%	0.01
Tariff/Imports			0.11	95%	0.13
Gross Output	63	96%	124	92%	237
Imports/GO	0.28	273%	0.53	59%	0.44
Exports/GO	0.11	-52%	0.03	492%	0.08
Machinery & Transport Equipment					
Value Added	46	132%	107	95%	209
Bank Loans/VA	0.43	150%	0.46	285%	0.91
Taxes/VA			0.12	11%	0.07
Tariff/Imports			0.05	219%	0.08
Gross Output	137	143%	332	70%	564
Imports/GO	0.53	362%	1.01	89%	1.12
Exports/GO	0.03	498%	0.07	244%	0.13

TABLE 1.1 (Continued)

Sector	1964	Change(%)	1967	Change(%)	1970
Other Manufacturing					
Value Added	7	74%	12	269%	43
Bank Loans/VA	0.86	384%	2.41	110%	1.37
Taxes/VA			0.11	450%	0.16
Tariff/Imports			0.18	196%	0.24
Gross Output	23	49%	34	63%	55
Imports/GO	0.16	278%	(0.42)	125%	(0.58)
Export/GO	0.21	460%	(0.83)	308%	(2.07)
All Service Sectors					
Value Added	920	90%	1,751	76%	3,074
Bank Loans/VA	0.13	125%	0.16	209%	0.28
Taxes/VA			0.15	18%	0.10
Tariff/Imports			0.35	8%	0.19
Gross Output	1,309	97%	2,573	88%	4,840
Imports/GO	0.00	201%	0.00	99%	0.00
Exports/GO	0.00	-52%	0.00	978%	0.00

*The sectoral tax rates were computed from the Financial Statement Analysis published by the Bank of Korea, which were based on sample observations of firms with more than 10 employees. Of course they do not include the personal income taxes.

The tax figures for all industries do not include the personal income taxes either. If we include them, the figures become 0.10 for 1967 and 0.13 for 1970.

The sectoral taxes/VA ratios for agriculture, fishery and mining stayed constant, while those for manufacturing and services have fallen from 0.16 to 0.14 and 0.15 to 0.10 respectively during 1967-1970. Hence the figures based on sample observations contradicts the Ministry of Finance figure for all industries which shows the increase from 0.07 to 0.10.

TABLE 1.2

SPEARMAN'S RANK CORRELATION COEFFICIENTS BETWEEN SECTORAL PERCENTAGE CHANGES DURING 1967-70*

	Value Added	Gross Outputs	Imports	Exports
Bank Loans	0.40	0.74**	-0.28	0.67**
Taxes	0.73**	0.31	-0.20	0.30
Tariffs	0.08	-0.13	-0.19	-0.13

*Sectoral percentage changes in absolute amount of current dollar values.
**Statistically significant at 0.05 level

In Japan, the scale of government investment and loans is equal to about 45% of the expenditure of the General Account Budget. The Trust Fund Bureau of the Ministry of Finance, which manages the utilization of funds entrusted by such special accounts as the Postal Savings Fund, the Welfare Annuity Fund, and the National Annuity Fund, supplies about two thirds of the government investment and loan funds. The subsidy policies of the Japanese Government after the Second World War (as well as those before the War) will be the major area of our historical investigation for this section.

In order to get a glimpse of Japan's subsidy policies, we prepared Table 1.3 which shows the allocation of lending funds by the Japan Development Bank, which takes less than 7% of the total government investment funds. The basic policy for each year is established by the Cabinet in the "Basic Policy for Employing Government Funds for Investment in Industrial Equipment and Facilities". The JDB's loans (as well as those of other government financial institutions such as Export-Import Bank of Japan) are a part of this overall program.

During 1951-60 period, the JDB emphasized the development of basic industries such as electric power, iron & steel, shipbuilding, etc. During 1961-70, the Bank focussed on promoting technological development which involves such sophisticated modern industries as nuclear power and electronic computers, and on encouraging regional and urban development including prevention of industrial pollution.

The JDB's share in the total supply of industrial equipment funds in Japan has been about 5% in recent years. The standard interest rate on the JDB is 8.5%, which is the same as the private long-term credit banks. But the JDB applies favorable rates to selected industries.

TABLE 1.3

LENDING PROGRAM OF THE JAPAN DEVELOPMENT BANK

Percentage (%)

Sector	51-65	1966	1967	1968	1969	1970
Regional Development	9.7	17.5	15.9	16.1	15.4	15.2
Urban Development	1.8	5.8	8.2	9.5	11.0	13.2
Distribution System	0.8	0.9	2.6	1.8	1.7	1.8
Development of Technology	2.4	4.9	5.6	8.1	9.9	11.4
Electricity	29.4	9.0	7.3	6.6	7.5	6.7
Petroleum Industry	0.1	3.6	3.9	4.4	4.8	4.1
Marine Transportation	25.6	41.3	37.8	35.9	33.6	31.3
Machinery & Electronics	3.7	3.1	3.4	2.9	3.4	2.9
Streamlining the Essential Industries	1.8	2.7	5.6	.5	5.8	5.6
Other Large Scale Industries	25.6	11.7	9.9	9.5	7.2	7.9
Total (millions of dollars)	3,783	619	647	758	811	950

III. A SHORT-RUN GENERAL EQUILIBRIUM APPROACH

One may approximate the changes in sectoral production and trade under different subsidy schemes on the basis of partial equilibrium calculations. However, it is well known that partial equilibrium approach will not permit unambiguous forecasts if changes in subsidies to number of sectors are being contemplated simultaneously. Moreover, policymakers usually do not know the general equilibrium consequences of subsidy intervention. Since every direct act of subsidizing some activity is also an indirect source of taxing others, one must have at least a rough idea of the overall impact of a complex of tax-subsidy scheme.[1]

Our approach will be developed on the basis of L. Taylor's model which is a local method of calculating resources pulls under various tax-subsidy schemes taking general equilibrium effects into account.

Our model will permit substitution between primary factors of production in response to price differentials, and will show the impact of change in the set of policy instruments (such as tariffs, export subsidies, indirect taxes, exchange rates or foreign capital inflows) upon sectoral outputs, sectoral allocation of capital and labor, volume of exports and imports, and prices of primary factors. On the basis of the established relationships between various subsidies and resource allocations, we hope to deduce a subsidy scheme which will maximize the national income stream.

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[1] The term "tax" is used to represent "negative subsidy" in our paper.

(1) Description of the Model

Simply put, Taylor's methodology is just what economists have always done when they analyze the effects of exogenous parameter changes on a market allegedly in equilibrium. A set of equations characterizing the equilibrium is written down and differentiated, and enough differential changes in exogenous variables are specified to permit inference of differential changes in the endogenous variables by solution of a system of linear equations. Naturally, this works only for "small" changes.[1] Taylor justifies his approach saying that such small changes are relevant because a protectionist country is not likely to remove all its tax-subsidies at once, or even in five years.

Following is a modified version of Taylor's model. Our basic assumptions are as follows:

(i) Demand for goods by consumers can be described by an aggregate utility function, with the convenient property of separability. This permits application of the Frisch /10/ method of computing all direct

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[1] For non-local effects, Johansen /15/ discusses integration of his growth model forward through time in a two-stage procedure: (1) make predictions of new levels of the endogenous variables from exogenous variables as we are doing here; (2) use these predictions as starting points for Gauss-Seidel iteration to determine a new equilibrium configuration for the economy, and continue from there. Taylor argues that there seems no computational reason why such a precedure could not be applied to a trade-oriented model to find the impacts of "large" tax-subsidy changes.

and cross-price elasticities using budget proportion and income elasticity of every good.

(ii) A modified small-country assumption is made about trading possibilities: imports have completely elastic supply, but demand elasticities for exports are less than infinite (though usually quite high).

(iii) We assume that the government imposes tariffs and indirect taxes, gives subsidies to various industries, and has an exogenously fixed expenditure vector. The difference between expenditures and tax revenues is covered by direct taxes on factor incomes, which are not calculated explicitly. Thus, equations linking factor payments, personal savings, and total consumption do not appear.

(iv) We will assume, as L. Taylor does, fixed coefficients for intermediate inputs and Cobb-Douglas (or CES) functions of primary factors for value added. Taylor works with only one variable primary factor of production, labor, assuming that capital is fixed. He argues that this short run assumption is made necessary by the existence of many goods and only two identifiable domestic factors of production. That is, with two factors and constant returns, only two goods (usually) would be produced after tax-subsidy changes; but with one variable factor and decreasing returns (which result from assuming capital stocks to be non-shiftable among sectors), all goods can continue in production.

Since the model is to examine sectoral resource allocation

with changes in tax-subsidy schemes, to fix the capital is to kill half of the usefulness of the model. We will make the allocation of capital endogenous, first by introducing a third category of primary factor called "specialized entrepreneurial ability" in addition to labor and capital. This "-ability" factor is a rather abstract concept, but since we will assume that this "-ability" factor (instead of capital in Taylor's model) is fixed and nonshiftable among sectors, its unquantifiable character would not make serious problems.

However, since the model will be dealing with only small incremental changes, it is unlikely that there will be a complete specialization in two goods. Therefore, we may well make both labor and capital variable without introducing any additional primary factor. We will experiment both approaches.

(v) In the spirit of emphasizing on-the-job skill training effects as well as skill supply constraints, we will classify labor into various types of skill groups.

The model incorporates all goods that are imported noncompetitively (i.e., not domestically produced) into a single sector (sector 0). We assume q_1 competitively imported goods, q_2 exports, and q_3 goods that are not traded at the base point of time. Thus of our n goods, $n - 1$ $(= q_1 + q_2 + q_3)$ are domestically produced. For brevity, we write equations in the log-differential form. Capital letters denote stocks or flows, primes their log-changes $(X' = dX/X)$.

M_j: the base year flow level of commodity j imports

E_j: the base year flow level of commodity j exports

a_{ij}: a fixed coefficient relating commodity i for intermediate uses to X_j, the base year production in sector j ($j \neq 0$)

C_j: the base year final consumption demand for commodity j

g_{jm}: the price elasticity of demand for C_j with respect to p_m, the price of consumed good m (all domestic producer prices will be assumed to be unity in the base year)

g_{jy}: the consumption elasticity with respect to Y, which represents total consumer expenditures, i.e., $Y = (1 - S) \sum_{j=1}^{n-1} p_j(X_j - \sum_{i=1}^{n-1} a_{ji}X_i)$ where S is the average propensity to save.

Z_j: the exogenous government investment and inventory change demand for commodity j

where $j = 0, 1, \ldots, n - 1$.

We begin with a flow equation for the non-competitive import sector:

$$M_0M_0' - \sum_{j=1}^{n-1} a_{0j}X_jX_j' - C_0(\sum_{m=0}^{n-1} g_{0m}p_m' + g_{0y}Y') - Z_0Z_0' = 0$$

(1 equation)

For the q_1 goods which are competitively imported, we have

$$X_iX_i' + M_iM_i' - \sum_{j=1}^{n-1} a_{ij}X_jX_j' - C_i(\sum_{m=0}^{n-1} g_{im}p_m' + g_{iy}Y') - Z_iZ_i' = 0$$

(q_1 equations.

where M_j is the volume of good j imported; and for the q_2 exports, we have

$$X_k X_k' - \sum_{j=1}^{n-1} a_{kj} X_j X_j' - C_k\left(\sum_{m=0}^{n-1} g_{km} p_m' + g_{ky} Y'\right) - Z_k Z_k' - E_k E_k' = 0$$

(q_2 equations)

where E_k is the volume of good k exported. Finally, the q_3 non-traded goods have similar balance equations, but lacking import and export terms:

$$X_j X_j' - \sum_{j=1}^{n-1} a_{ij} X_j X_j' - C_i\left(\sum_{m=0}^{n-1} g_{im} p_m' + g_{jy} Y'\right) - Z_j Z_j' = 0$$

(q_3 equations)

The log-change of the domestic price of (non) competitively imported good is determined by the log-changes of one-plus-the-tariff (t_j) and of the exchange rate (r),

$$p_j' - t_j' - r' = 0 \qquad (1 + q_1 \text{ equations})$$

Export prices are assumed to vary in the world market, so that

$$p_k' - h_k' - \phi_k' - r' = 0 \qquad (q_2 \text{ equations})$$

where ϕ_k is one-plus-the-subsidy over f.o.b. value for export k; h_k is the world price of export k. The world prices are assumed to be tied to export volumes by constant elasticity demand functions,

$$E_k' - v_k h_k' = 0$$

where v_k is the elasticity of export demand for good k.

Assuming s different types of labor, we may specify the Cobb-Douglas production function in the following form:

$$X_j = A_j K_j^{\delta_j} L_{1j}^{\sigma_{1j}} \ldots L_{sj}^{\sigma_{sj}} U_j^{u_j} \qquad (j = 1, \ldots, n-1)$$

where A_j is the multiplicative factor, K_j is capital employed in sector j, L_{ij} is labor type i employed in sector j, U_j is the "-ability" factor employed in sector j, while δ_j, σ_{ij}, and u_j represent the output elasticity with respect to each primary factor (the Cobb-Douglas exponent). With constant returns to scale, since the total value added will be exhausted by the payments to each factor according to their marginal productivities, we have

$$\delta_j + \sigma_{1j} + \ldots + \sigma_{sj} + u_j = 1$$

Without loss of generality, we may set unity for U_j, then we get

$$X_j = A_j^* K_j^{\delta_j} L_{1j}^{\sigma_{1j}} \ldots L_{sj}^{\sigma_{sj}}$$

where A_j^* reflects the impact on A_j of the change in unit of U_j. Since we are interested in short run functions assuming that "-ability" factor is fixed in each sector, this unity conversion simplifies the functional expression.

Since we treat "-ability" factor, U_j, as a fixed factor, an s + 2 factor production function would give an expression for the log-change of product in the n production sectors of the form

$$X_j' - \sum_{i=1}^{s} \sigma_{ij} L_{ij}' - \delta_j K_j' = 0 \qquad \text{(n - 1 equations)}$$

If we define a net price p_j^* as the amount an entrepreneur receives for distribution to factors after deducting intermediate input costs and indirect tax-subsidies (at rate θ_j),

$$p_j^* = p_j - \sum_{i=0}^{n-1} a_{ij} p_i - \theta_j \qquad (j = 1, \ldots, n - 1)$$

then the logarithmic derivatives of his factor demand equations will be

$$(p_j^*)' + X_j' - w_i' - L_{ij}' = 0 \qquad \text{(s x (n-1) equations)}$$

and

$$(p_j^*)' + X_j' - z' - K_j' = 0 \qquad \text{(n-1 equations)}$$

where w_i is the economy-wide wage rate to labor type i (to which sector wages, if different, are assumed to be proportional); and z is the economy-wide return to capital (again sectoral returns may only be proportional to z) and

$$(p_j^*)' = (p_j^*)^{-1}(dp_j - \sum_{i=0}^{n-1} a_{ij} dp_i - d\theta_j)$$
$$= (1 - \sum_{i=0}^{n-1} a_{ij} - \theta_j)^{-1}(p_j' - \sum_{i=0}^{n-1} a_{ij} p_j' - \theta_j \theta_j')$$

on the assumption that base year producer's prices are unity.

If we treat "-ability" as the fixed factor, we may let r_i represent an independent rate of profits in each sector. Then, the demand equation for "-ability" only relates changes in independent

sectoral rates of profits to price changes,

$$(p_j^*)' + X_j' - \gamma_j' = 0$$

Finally, we complete the system by relating change in labor and capital use to total supply (L_i and K),

$$\sum_{j=1}^{n-1} L_{ij} L_{ij}' - L_i L_i' = 0 \qquad \text{(s equations)}$$

$$\sum_{j=1}^{n-1} K_j K_j' - KK' = 0 \qquad \text{(1 equation)}$$

and by the balance of payments constraint,

$$FF' + \sum_{k=1}^{n-1} h_k E_k (h_k' + E_k') - \sum_{j=0}^{n-1} M_j M_j' h_j = 0 \qquad \text{(1 equation)}$$

where, once again, import prices do not vary, $KK' = SY + FF'$, and F is the foreign capital inflow, exogenously given.

Demand and supply are determined by relative price changes and are linked by the exchange rate which enters as the price counterpart of the capital inflow. In fact the supply change reduces to the familiar formula,

$$X_j' = \frac{\sum_{i=1}^{s} \sigma_{ij} + \delta_j}{1 - \sum_{i=1}^{s} \sigma_{ij} - \delta_j} (p_j^*)' - \frac{\sum_{i=1}^{s} \sigma_{ij} w_i' + \delta_j z'}{1 - \sum_{i=1}^{s} \sigma_{ij} - \delta_j}$$

where the change in the net price due to tariff and exchange rate changes determines the production response. This supply-side simplicity results in part from the assumption of fixed input-output coefficients.

The following variables are naturally tagged as exogenous: the final government demand changes Z_i', the force of tariffs t_j', the forces of export subsidies $\emptyset_j'$, the indirect tax rates θ_j', the total supply of labor L_j' ($j = 1, \ldots, s$), capital accumulation K' and the capital inflow F'.

Endogenous variables are import changes M_i', exports E_j', production changes X_j', total consumption Y', domestic prices p_i', world prices of exports h_j', sectoral employments L_{ij}' and K_j' and rates of return r_j', w_i', and z'.

Suppose now that we group all the endogenous log-changes in a vector 'a' and the exogenous changes in vector 'b'. Then the system can be written in a general matrix form as

$$Ma + Nb = 0$$

which can be solved in the following form:

$$a = - M^{-1}Nb$$

The basic data required are an interindustry flow table including a breakdown of value added, employment data, data on volumes of imports and exports and their world prices, and some notion of income and price elasticities of consumer demand.

With the type of model described here, one can get local general equilibrium predictions of resource pulls resulting from changes in commercial policy with scarcely more computational and data gathering effort than is required for a standard effective protection study.

(2) Empirical Results

We tried an experimental application of our model for Korea using the 1968 I-O Table and other related data. As a first step, we assumed homogeneous labor without classifying it into various skill groups (i.e., we set s = 1), and further, we aggregated the industries into 15 sectors (n = 16 if we include the non-competitive import sector). This resulted in an 80 x 80 M matrix, an 80 x 50 N matrix and a 50 x 1 vector b of exogenous variables. The components of the b vector are the rates of changes in: import tariffs (1, ..., 5), export subsidies (6, ..., 16), indirect taxes (17, ..., 31), government and other exogenous consumptions (32, ..., 47), total labor supply (48), total capital supply (49), and the foreign capital inflow (50).

We examined the impact of unit increase in each exogenous variable separately. The response elasticities are presented in Table 1. Since the model has linear relationships, any combined impacts of simultaneous changes in more than one exogenous variables can be computed by simple additions and subtractions of each individual changes. Likewise, the impact of two unit increase in an exogenous variable is twice of the impact of one unit change. We assumed -10 for the price elasticity of export demand for each exported good. Other price elasticities were measured using Frisch method.

In 1968, the tariff rates for imported goods were: 11% for non-competitive imports, 1% for agricultural products, 19% for chemicals, 12% for metal products and 8% for machineries. A 10% increase in tariff

rates implies $t_1' = 0.01$, $t_4' = 0.001$, $t_2' = 0.016$, $t_3' = 0.011$, and $t_5' = 0.0074$. According to the response elasticities shown in Table 1, these imply that the 10% increase in tariff rate will raise the domestic price of chemicals by 2%, those of non-competitive imports, metal products and machinery by 1% each, and that of agricultural product by almost zero percent. The impact of this extra tariff protection is the increase in outputs of chemicals, metal products and machinery by about 3% each and almost no change in agricultural production. At the same time, the imports of chemicals, metal products and machinery decrease by about 17%, 10%, and 5% respectively. The imports of non-competitive products and agricultural products decrease only by about 1% each.

We have not measured the magnitude of sectoral export subsidies in 1968. We do know that they vary widely among sectors Since the magnitude of 1968 sectoral export subsidies computed by B. Balassa, et. al., will be available in near future, we will illustrate the subsidy effects simply by assuming 25% ad valorem export subsidy in base period and then 10% increase in it, implying $\delta_k' = 0.02$.

Under these assumptions, the 10% increase in export subsidy raises the producer's price of each export good by 0.2 ~1.2% except in cases of food, miscellaneous manufactures, and services which have negligible changes. The outputs increase very significantly in textile (2.2%) and non-metallic mineral products (2.3%); moderately in mining (1.8%), transportation (1.2%), miscellaneous manufacturing (0.6%), construction (0.6%) and electricity (0.6%); and negligibly in the rest of the sectors.

The impact of 10% increase in export subsidy on export expansion of each good ranges from 8% to 20% of export increases. The subsidy effect seems to have been exaggerated a little because of the price equation $p_j^i = h_j^i - \emptyset_j^i - r'$ which I adopted from Taylor's model without modification. The price change in the above equation represents the change to producers and yet applied also to the domestic consumers of each export good. Hence what we observe is the combined result of direct export promotion by 10% increase in export subsidy to producers and indirect export promotion of discouraging domestic consumption by 10% increase in consumer price.

Since export subsidies are usually handed to producers by the government, and not directly by the consumers themselves, we will add the price equation for consumers (such as $p_j^c - h_j^i - r' = 0$) in our next experiment. In any case, we can interpret our result such that the direct export subsidies together with discouragement of domestic consumption work very strongly for export expansion.

In most cases, the increase in tariff rates or export subsidies results in appreciation of exchange rates.

If we introduce a 10% tariff increase on all imported goods or a 10% export-subsidy increase on all exported goods simultaneously, the import substitution and export promotion effects become much smaller than those suggested by individual changes separately. These results simply reflect the limitation of available resources, and the mutually offsetting effect of simultaneous increases in tariffs or export subsidies

due to the fact that a subsidy on one sector is in relative sense a negative subsidy on other sectors and a subsidy to every producer and consumer is no subsidy to anybody at all. Therefore, we should be very careful when we would like to have an overall picture of the impacts of various import substitution and export expansion policies all together.

We also experimented the impact of 10% increase in indirect taxes, but most of the sectors show insignificant responses to the change in indirect taxes. These results might be explained by the fact that, although indirect taxes take 12.5% and 8.4% of total input value in food manufacturing and chemicals, in other manufacturing sectors, the indirect taxes usually take less than 2% of total input values.

In order to examine the impact of changes in factor supplies on commodity and factor prices, outputs, imports, exports, exchange rate, and sectoral resource allocation, we also experimented 10% increase in labor, capital and foreign capital supplies. Again, we examined the individual impact separately. The results are presented in Table 2.

The 10% increase in labor supply reduces the wage rate by 10%, raises the interest rates only by 0.1% and appreciates the exchange rate by 3.9%. The 10% increase in capital supply reduces the interest rate by 9.9%, raises the wage rate only by 0.1%, and appreciates the exchange rate by 0.3%. The 10% increase in foreign capital inflow lowers the wage, interest and exchanges rates by 5.8%, 5.0% and 6.1% respectively

The 10% increase in labor supply lowers the output prices by 1.9%~8.8%, lowers the import of agricultural product very significantl

(by 24.6%), and raises the exports of fishery by 48.9%. The use of labor in each sector increases by varying degrees. We can also observe intersectoral reallocation of capital. The decrease in capital stock in any sector might be interpreted as non-replaced portion of depreciated capital stock.

On the other hand, the impact of 10% increase in capital stock is rather insignificant. Output prices fall by less than 1%, and outputs, imports and exports change by less than 2~3%, in spite of the fact that capital stock of each sector has increased by 9~12%.

This result seems to suggest that we (i.e., 1968 I-O Table) attributed too much portion of value added to entrepreneurial "-ability" factor in the form of profits. We will have narrower definition of entrepreneurial profit and hence increase the contribution of capital to a proper level in our next experiment. We may also experiment two factor model with only wage and interest components, in which both labor and capital are mobile, instead of three-factor model. We may not get complete specialization that Taylor worried.

It seems that, if we properly modify the model-framework and refine the basic data, our model will be able to give us useful informations on the impacts of small changes in policy variables such as tariffs, export subsidies, indirect taxes, and foreign capital inflows (or exchange rate) upon factor and output prices, sectoral outputs, imports, exports, resource allocations and hence upon national income. Furthermore, the model can also examine the impact of change in factor supplies.

Since we need much more refinements in data and the structure of the model itself, we will not elaborate further our experimental result now.

The next experimental step will be to classify the labor into various skill groups, to make the foreign exchange rate a policy variable, to compute explicitly the impact of various tax-subsidy schemes on the national income level (in order to locate the income maximizing tax-subsidy scheme), to refine the basic data, to estimate the magnitudes of sectoral export subsidies, and to up-date the data to 1970. Of course, we will also try to improve the basic framework of our model.

Table 1. Response Elasticities

Sector	Import Tariffs						Export Subsidies											
	t_0'	t_1'	t_2'	t_3'	t_4'	sum	ϕ_5'	ϕ_6'	ϕ_7'	ϕ_8'	ϕ_9'	ϕ_{10}'	ϕ_{11}'	ϕ_{12}'	ϕ_{13}'	ϕ_{14}'	ϕ_{15}'	sum
Prices (p')																		
Non-Comp. Imports	.99	-.63	-.05	.03	-.08	.26	-.03	-.02	-.05	-.02	.07	-.04	.02	-.01	-.05	-.11	-.01	-.25
Agricultural Product	-.01	.37	-.05	.03	-.08	.26	-.03	-.02	-.05	-.02	.07	-.04	.02	-.01	-.05	-.11	-.01	-.25
Chemicals	-.01	-.63	.95	.03	-.08	.26	-.03	-.02	-.05	-.02	.07	-.04	.02	-.01	-.05	-.11	-.01	-.25
Metal Products	-.01	-.63	-.05	1.03	-.08	.26	-.03	-.02	-.05	-.02	.07	-.04	.02	-.01	-.05	-.11	-.01	-.25
Machinery	-.01	-.63	-.05	.03	.92	.26	-.03	-.02	-.05	-.02	.07	-.04	.02	-.01	-.05	-.11	-.01	-.25
Fishery	-.01	-.67	.03	.10	.07	-.57	.57	-.01	-.04	.08	.17	-.05	.07	-.01	-.05	-.13	-.02	.58
Mining	-.08	-.38	.13	.13	.00	-.20	-.03	.28	-.05	.01	.12	-.04	.04	.00	-.04	-.10	-.01	.18
Food	-.03	-.18	.03	.04	.05	-.09	.00	.00	.03	.03	.08	-.02	.04	.00	-.01	-.04	-.01	.10
Textile	.03	-.43	.07	.05	-.01	-.29	-.03	-.01	-.04	.40	.08	-.03	.03	.00	-.02	-.08	-.01	.29
Non-Metallic	.16	-.51	.00	.06	.00	-.29	-.03	.00	-.04	.01	.44	-.03	.06	.00	-.03	-.08	-.01	.29
Misc. Manufacture	.07	-.36	.05	.08	.05	-.11	-.02	-.01	-.03	.04	.10	.05	.04	.00	-.03	-.05	-.01	.08
Construction	.03	-.30	.00	.15	.06	-.06	-.03	.00	-.04	.02	.16	-.03	.10	-.01	-.02	-.07	-.01	.07
Electricity	-.11	-.51	.15	.13	.11	-.23	-.02	.03	-.03	.07	.12	-.02	.04	.15	-.04	-.06	-.01	.23
Trade	-.10	-.51	.03	.08	.14	-.36	-.02	-.01	-.03	.07	.11	-.02	.05	.00	.23	-.01	-.01	.36
Transportation	-.05	-.43	.05	.05	.04	-.34	-.02	-.01	-.04	.02	.08	-.03	.03	-.01	-.03	.36	-.01	.34
Other Services	-.04	-.18	.03	.10	.07	-.02	-.02	.00	-.03	.05	.09	-.02	.04	-.01	-.02	-.05	.00	.03
Outputs (X')																		
Agricultural Product	.06	.34	-.06	-.04	-.10	.20	.00	-.01	-.01	-.07	-.02	-.01	-.02	.00	-.03	-.04	.00	-.21
Chemicals	-.35	-.49	1.52	-.08	-.15	.45	-.01	-.07	-.02	-.09	-.03	-.02	-.02	-.01	-.07	-.12	-.01	-.47
Metal Products	-.21	-1.20	-.41	3.42	-.48	1.12	-.01	-.11	-.04	-.22	-.12	-.05	-.06	-.03	-.23	-.23	-.01	-1.11
Machinery	-.21	-1.02	-.32	-.93	3.41	.94	-.01	-.03	-.04	-.19	-.12	-.05	-.05	-.02	-.22	-.21	-.01	-.95
Fishery	.06	.05	-.03	-.07	-.03	-.02	.02	.01	.04	-.06	-.08	.03	-.03	.01	.01	.07	.07	.03
Mining	-.12	-.72	.30	.05	-.17	-.66	.00	.89	-.01	-.09	.08	-.02	.01	-.01	-.08	-.09	-.01	.67
Food	-.03	-.30	.03	-.02	.10	-.22	-.01	.01	.12	.03	.01	.02	.02	.00	.00	.04	.00	.24
Textile	-.13	-.42	-.23	-.05	-.08	-.91	.00	-.01	-.01	1.10	-.02	-.01	-.01	-.01	-.07	-.05	.00	.91
Non-Metallic	-.37	-.41	-.11	-.08	-.03	-1.00	.00	-.04	-.01	-.06	1.16	-.01	.10	-.01	-.07	-.07	.00	.99
Misc. Manufactures	-.12	-.23	-.01	-.05	.07	-.34	.00	.00	.02	.01	.01	.30	.02	.00	-.03	.01	.00	.34
Construction	-.01	-.12	-.01	-.04	-.04	-.22	.00	.00	.00	-.01	-.03	.00	.29	.00	-.01	-.01	.00	.23
Electricity	-.06	-.30	.04	.05	.06	-.21	.00	.02	-.01	.04	.03	.01	.00	.16	-.03	-.02	.00	.20
Trade	.01	-.14	-.01	-.01	.04	-.11	.00	.00	.00	.00	.00	.00	.00	.00	.13	-.03	.00	.10
Transportation	.02	-.40	-.09	-.03	-.06	-.56	.00	.00	.00	-.03	-.01	.00	.00	.00	-.03	.61	.00	.54
Other Services	-.03	-.20	.02	.05	.08	-.08	.00	.01	.01	.01	.00	.01	.01	.00	-.01	.02	.02	.08

Table 1. Response Elasticities (Continued)

Sector	Import Tariffs						Export Subsidies											
	t'_0	t'_1	t'_2	t'_3	t'_4	sum	$\emptyset'_5$	$\emptyset'_6$	$\emptyset'_7$	$\emptyset'_8$	$\emptyset'_9$	$\emptyset'_{10}$	$\emptyset'_{11}$	$\emptyset'_{12}$	$\emptyset'_{13}$	$\emptyset'_{14}$	$\emptyset'_{15}$	sum
Imports (M')																		
Non-Comp. Imports	-.16	-.32	.21	.01	.12	-.14	.00	-.02	.00	.08	.15	.01	.02	-.01	-.05	-.05	.00	.13
Agricultural Product	-1.42	-10.91	1.63	.69	3.25	-6.76	.05	.34	.68	1.99	.63	.38	.60	.03	.72	1.25	.09	6.76
Chemicals	1.16	1.70	-8.58	.37	1.48	-3.87	.06	.37	.19	1.26	.23	.21	.17	.07	.03	1.02	.04	3.65
Metal Products	.18	1.58	.86	-10.39	5.34	-2.43	.02	.34	.08	.35	.24	.12	.53	.07	.30	.35	.03	2.43
Machinery	.20	1.29	.46	1.11	-4.64	-1.58	.02	.07	.08	.30	.15	.09	.14	.03	.28	.41	.02	1.59
Exports (E')																		
Fishery	.89	.39	-.81	-.71	-1.50	-1.74	4.00	-.04	-.08	-1.01	-.99	.11	-.53	.05	-.02	.20	.05	1.74
Mining	.67	-2.49	-1.84	-1.06	-.80	-5.52	.00	7.05	-.05	-.35	-.50	-.06	-.18	-.06	-.16	-.16	-.01	5.52
Food	.15	-4.48	-.77	-.15	-1.33	-6.58	-.25	-.12	9.22	-.55	-.15	-.22	-.17	-.05	-.40	-.71	-.05	6.55
Textile	-.43	-1.98	-1.22	-.18	-.72	-4.53	-.03	-.06	-.09	5.77	-.12	-.10	-.09	-.03	-.33	-.37	-.02	4.53
Non-Metallic	-1.73	-1.21	-.54	-.28	-.81	-4.57	-.01	-.18	-.06	-.25	6.23	-.10	-.43	-.04	-.27	-.31	-.01	4.57
Misc. Manufactures	-.81	-2.73	-1.02	-.51	-1.31	-6.38	-.06	-.10	-.16	-.62	-.38	9.09	-.20	-.04	-.50	-.60	-.04	6.39
Construction	-.38	-3.29	-.48	-1.24	-1.39	-6.78	-.02	-.13	-.07	-.44	-.88	-.10	9.19	-.02	-.36	-.39	-.02	6.76
Electricity	1.00	-1.20	-1.95	-1.05	-1.93	-5.13	-.05	-.41	-.21	-.95	-.55	-.22	-.20	8.42	-.14	-.54	-.04	5.11
Trade	.90	-1.25	-.77	-.50	-2.17	-3.79	-.05	-.12	-.23	-.95	-.42	-.25	-.29	-.04	7.21	-1.04	-.04	3.78
Transportation	.35	-1.96	-.98	-.19	-1.17	-3.95	-.05	-.07	-.13	-.40	-.14	-.13	-.14	-.02	-.25	5.31	-.03	3.95
Services	.34	-4.51	-.76	-.73	-1.53	7.19	-.05	-.14	-.17	-.70	-.24	-.22	-.20	-.03	-.36	-.61	9.89	7.17
Wage (w')	-.08	.09	-.04	.07	.02	.13	-.03	-.01	-.04	.06	.09	-.03	.04	-.01	-.03	-.09	-.01	-.13
Interest (s')	-.18	-.67	.09	.11	.15	-.31	-.03	-.01	-.02	.10	.15	-.02	.05	.01	.13	.13	-.01	.29
Exchange Rate (r')	-.01	-.63	-.05	.03	-.08	-.79	-.03	-.02	-.05	-.02	.07	-.04	.02	-.01	-.05	-.11	-.01	-.2

Table 2. Impact of a 10% Increase in Supply of Labor, Capital, and Foreign Capital on Prices, Outputs, Imports, Exports and Sectoral Allocation of Capital and Labor

unit: percent (%)

Sector	10% Increase in Labor Supply					10% Increase in Capital Supply					10% Increase in Foreign Capital				
	Price	Output	Im&Ex	Labor	Capital	Price	Output	Im&Ex	Labor	Capital	Price	Output	Im&Ex	Labor	Capital
Non-Comp.Imp.	-3.9	-	1.9	-	-	-0.3	-	0.7	-	-	-6.1	-	-0.5	-	-
Agricultural	-3.9	4.5	-24.6	10.7	0.4	-0.3	0.1	8.1	-0.3	9.7	-6.1	-0.4	21.3	-1.0	-1.7
Chemicals	-3.9	1.3	20.0	6.4	-3.8	-0.3	0.8	1.9	0.6	10.5	-6.1	-1.6	13.3	-5.1	-5.9
Metal Products	-3.9	5.3	-3.8	11.3	1.0	-0.3	1.4	0.4	1.7	11.6	-6.1	-2.5	4.1	-4.6	-5.4
Machinery	-3.9	4.4	0.4	9.8	-0.5	-0.3	2.7	2.2	2.8	12.8	-6.1	-2.4	5.3	-4.1	-4.9
Fishery	-8.8	7.5	48.9	19.4	9.2	0.1	0.2	-4.0	0.3	10.3	-10.2	5.1	41.1	13.1	12.3
Mining	-5.5	4.2	16.1	7.3	-3.0	-0.3	0.7	0.1	0.5	10.4	-6.0	-0.9	-1.8	-1.5	-2.3
Food	-2.1	4.6	-18.7	17.3	7.0	-0.1	1.0	-2.0	1.6	11.6	-4.4	1.4	-16.9	4.7	4.0
Textile	-4.2	2.9	2.1	7.7	-2.6	-0.7	1.3	3.5	0.4	10.4	-5.6	-0.3	-5.8	-0.5	-1.2
Non-Metallic	-4.3	2.2	3.5	6.6	-3.7	-0.6	0.9	2.6	0.1	10.0	-5.8	-0.7	-3.2	-1.3	-2.0
Misc. Manuf.	-4.4	4.4	4.3	8.7	-1.5	-0.5	1.0	2.3	0.5	10.4	-5.3	0.8	-3.6	1.5	0.7
Construction	-6.0	0.9	20.8	1.9	-8.4	-0.4	0.2	1.4	-0.2	9.7	-5.8	-0.1	-3.7	-0.1	-0.9
Electricity	-2.3	3.6	-16.0	12.5	2.2	0.0	1.0	-2.7	1.2	11.1	-4.9	0.2	-12.1	0.6	-0.1
Trade	-1.9	1.7	-20.4	10.3	0.0	-1.9	1.7	16.3	-0.7	9.2	-4.9	0.1	-12.6	0.7	-0.1
Transportation	-3.7	4.9	-24.9	11.2	0.9	-0.1	0.6	-2.1	0.7	10.7	-5.2	0.3	-9.3	0.8	0.0
Services	-5.0	4.1	10.3	8.5	-1.8	-0.2	0.7	-1.5	0.6	10.6	-5.1	0.8	-10.8	1.6	0.8
	wage	interest	exchange rate			wage	interest	exchange rate			wage	interest	exchange rate		
	-10.2	0.1	-3.9			0.1	-9.9	-0.3			-5.8	-5.0	-6.1		

Table 3. Direct and Cross Price Elasticities of Demand

Sector	g_{iy} \ π_i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		0.00	0.33	0.04	0.00	0.02	0.03	0.00	0.15	0.07	0.00	0.03	0.00	0.01	0.17	0.06	0.10
0. Non-Comp.Imp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Agricultural	0.52	0.00	-0.52	-0.01	0.00	0.01	-0.01	0.00	-0.01	-0.02	0.00	-0.01	0.00	0.00	-0.06	0.00	-0.03
2. Chemicals	1.57	0.00	-0.38	-1.57	0.00	0.02	-0.03	0.00	-0.02	-0.07	0.00	-0.02	0.00	0.00	-0.18	-0.01	-0.08
3. Metal Product	1.00	0.00	-0.24	-0.01	-1.00	0.01	-0.02	0.00	-0.01	-0.05	0.00	-0.01	0.00	0.00	-0.11	0.00	-0.05
4. Machinery	3.15	0.00	-0.76	-0.03	-0.01	-3.15	-0.06	0.00	-0.04	-0.15	0.00	-0.04	0.00	0.00	-0.36	-0.01	-0.32
5. Fishing	0.52	0.00	-0.13	-0.01	0.00	0.01	-0.52	0.00	-0.01	-0.02	0.00	-0.01	0.00	0.00	-0.06	0.00	-0.03
6. Mining	0.89	0.00	-0.22	-0.01	0.00	0.01	-0.02	-0.89	-0.01	-0.04	0.00	-0.01	0.00	0.00	-0.10	0.00	-0.04
7. Food	1.82	0.00	-0.44	-0.02	0.00	0.02	-0.03	0.00	-1.82	-0.09	0.00	-0.02	0.00	0.00	-0.21	-0.01	-0.09
8. Textile	0.71	0.00	-0.17	-0.01	0.00	0.01	-0.01	0.00	-0.01	-0.71	0.00	-0.01	0.00	0.00	-0.08	0.00	-0.04
9. Non-Metallic	0.82	0.00	-0.20	-0.01	0.00	0.01	-0.02	0.00	-0.01	-0.04	-0.82	-0.01	0.00	0.00	-0.09	0.00	-0.03
10. Misc. Manuf.	1.22	0.00	-0.29	-0.01	0.00	0.01	-0.02	0.00	-0.02	-0.06	0.00	-1.22	0.00	0.00	-0.14	0.00	-0.06
11. Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12. Electricity	1.97	0.00	-0.47	-0.02	0.00	0.02	-0.04	0.00	-0.03	-0.09	0.00	-0.02	0.00	-1.97	-0.22	-0.01	-0.10
13. Trade	0.67	0.00	-0.20	-0.01	0.00	0.01	-0.01	0.00	-0.01	-0.03	0.00	-0.01	0.00	0.00	-0.67	0.00	-0.03
14. Transportation	1.89	0.00	-0.57	-0.02	0.00	0.02	-0.04	0.00	-0.03	-0.09	0.00	-0.02	0.00	0.00	-0.21	-1.89	-0.09
15. Service	1.04	0.00	-0.25	-0.01	0.00	0.01	-0.02	0.00	-0.01	-0.05	0.00	-0.01	0.00	0.00	-0.12	0.00	-1.04

* π_i represents the budget proportion of the ith good; g_{iy} is the income elasticity of the ith good. We assumed -2 for the "money flexibility".

IV. A LONG-RUN PROGRAMMING APPROACH

This external economy model of on-the-job labor-augmenting skill-production is focussed on the computation of the shadow prices of primary inputs and externalities (on-the-job skill production), and the determination of optimum investment, production and trade pattern subject to available factor supplies.

The objective of planning in our model is to maximize discounted income stream (valued at international prices) through optimum investment policies on sectoral production capacities subject to savings and labor supplies which are available during a T-year planning period.

The model is based on the input-output accounting framework and is dynamic in the sense that a number of time periods are tied together by factor supplies and capacity accounting relationships. The model includes a single period gestation lag between on-the-job skill training and the resulting labor-augmenting skill increase. However, it does not assume any gestation lag between the investment, and capacity expansion.

The model includes production, import, exports, and capacity expansion activities for each of the aggregate sectors. The technology in each sector is fixed and given by a set of constant input-output and input-capacity coefficients. Capital costs enter through capacity utilization constraints which limit production to the available capacity. We will assume full utilization of capacities in each period. We will assume

increasing returns to scale in the expansion of physical production capacity and constant returns to scale in intermediate input use.[1] We will assume the depreciation of capital in a very simplified form. Labor costs enter through production constraints which limit production to the available labor supply. We will not assume full employment of labor in each period.

Hence, our model will show the "potentially maximal" growth possibility which may be achieved through optimum investments on sectoral production capacities in an economy with varying degrees of under-employment in various types of skilled and unskilled labor.

The aggregation necessary to yield the volume concepts are assumed to be performed by means of the constant international commodity prices (or domestic prices multiplied by "effective" exchange rate) existing at the base point of time.

The model include the on-the-job skill production, though in a very simplified form. Despite the central importance of learning effects to trade and development policy, very little empirical effort has been devoted to finding out which industries actually generate valuable human resources in industrially backward countries and in what circumstances. All manufacturing industries require

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[1] Our assumption is partly based on the findings of J. Haldi and D. Whitcomb /11/. Their main conclusion is that in many basic industries, such as petroleum refining, primary metals, and electric power, economies of scale are found up to very large plant sizes (often the largest built or contemplated). These economies occur mostly in the initial investment cost and in operating labor cost, with no significant economies observed in raw material cost.

skilled labor in greater or smaller proportion to the unskilled labor force of the industry; that is, each industry requires managers, engineers, machinists, electricians and other skilled occupations. The fact that these workers are required, however, has a double-edged impact on the skill supplies available to the economy. On the one hand, the industry subtracts from the skills available to the rest of the economy, by employing scarce skilled workers. On the other hand, the industry adds to the human resources of the economy by on-the-job training. Thus, in every industry there is an input and an output of skill, as in any other activity devoted wholly or partly to training. Moreover, as a rule skilled practitioners are required to train newcomers in any particular occupation. The employment pattern of the skilled labor force at any one time can therefore be viewed as a deployment to meet at once the training needs and the current production needs of the society.

The research would be carried out in several stages, starting with the formulation and implementation of an extremely simplified programming model.

In our linear programming approach, we will assume constant international prices for all tradable commodities: i.e., infinite price elasticities of demand and supply of each good. If limitless exports of each commodity were possible at a constant international price, then the economies of scale problem will lose much of its significance because any production project can be started with optimum scale regardless of the size of domestic market, subject only to cost-externality considerations

and factor supply conditions.[1]

Optimal solutions to dynamic input-output models are characterised by specialization in one or two exports with the foreign exchange revenue being used to pay for imports of those commodities whose production is not expanded beyond the initially available capacity. It can be said that if it pays to export a commodity, then it pays to export as much as possible since there are constant returns to scale and demand is perfectly elastic. (Increasing returns to scale will amplify this tendency.)

The usual procedures for a more "reasonable" behavior of the model are to make exports exogenous or to use step functions for the export demand equations. In the latter alternative the unit revenue from exporting a given commodity falls discretely as each new step is encountered. One may assume that unit export revenue for each commodity is constant but the amount exported cannot exceed a given upper bound.

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[1] Even if we assume a set of constant international commodity prices, since it costs any firm breaking into a foreign market to cultivate a market of effectively infinite price elasticities, the measurement of this initial cost may be desirable.

We can also assume non-infinite price elasticities in international market. In this case, the choice of project combinations and their scales will alter the initial structure of relative prices.

The measurement of social profitability could also be made against a pattern of changing future prices. Given the degree of uncertainty attached to all future economic magnitudes, however, this is not likely to be a very useful procedure.

Beyond the upper bound one can think of there being another step on which unit export revenue is zero. Sometimes an upper bound on each competitive import activity is also included in order to prohibit unreasonably high import levels and to assure capacity expansion in every sector. [35]

The use of these constraints only frustrates the tendency toward extreme specialization in trade and production. The constraints do not, in themselves, make the specification of the production functions or export demand functions more realistic. Thus, their introduction should be seen as an ad hoc measure to insure that solutions will assume a "reasonable" look. But with these type of artificial constraints, it is very difficult to infer from a single solution just where the economy's long run comparative advantage, relative to world market prices, lies. The very act of intuitively setting up the "export-import" upper bounds is identical to intuitively determining the economy's long-run comparative advantage, depriving the model of any kind of policy implications for efficient resource allocation based on comparative advantage.

The tendency for extreme specialization in a few export commodities, subject to factor supply constraints, can at least dramatize where the economy's long-run comparative advantage lies. After all, the merit of model-building is its capability to disclose some essential nature of complicated reality in a simple and clear form, although the simplicity and clarity are frequently quite exaggerated.

Our programming problem is:

(1) To select the series of $q(1), \ldots, q(T)$ for a T-year planning such that;

(2) The discounted national income stream (valued at constant international commodity prices) is maximized i.e.,

$$\text{Max} \sum_{i=1}^{n} \sum_{t=1}^{T} (1 - \sum_{j=1}^{n} a_{ji})\, q_i(t) \left[\sum_{\tau=0}^{T_i^*-1} r(t+\tau)(1 - \delta_i \tau) \right]$$

where

$A = (a_{ij})$: an n x n matrix of non-primary input coefficients per dollar's worth of outputs,

$q(t)$: an n x 1 vector of net increase in production activity (capacity, since we are assuming full utilization of capacities) in period t,

T_i^* : the life time of capacity in i-sector in the sense of $1 - \delta_i T^* = 0$, where δ_i is the constant rate of capacity depreciation in i-sector.

Capacity is measured in dollar's worth of annual output, i.e. a unit of capacity in sector j is the capital stock required to produce a dollar's worth of j-product.

(3) Subject to capital and labor supply constraints

(a) $\sum_{i=1}^{n} g_i(t) = s(t)Y(t) + \emptyset(t)$

where

$g(t) = \bar{B} + Bq(t)$, assuming $q_i > 0$, or

$g(t) = \bar{B}z(t) + Bq(t)$, without assuming $q_i > 0$, where $z(t)$ is an n x 1 vector of zero-one ($z_i(t)$ is a zero-one variable equal to zero if there is no capacity expansion, and equal to one if there is capacity expansion in sector i.)

$B = (b_{ij})$: an n x n matrix of non-primary input requirements coefficients per unit expansion of capacity,

$\bar{B} = (\bar{b}_{ij})$: an n x n matrix of fixed non-primary input-requirements coefficients per any unit of expansion in capacity. The fixed input requirements for capacity expansion imply penalty costs for a piecemeal capacity expansion lasting more than one year. The average cost of a unit capacity expansion in sector j is $\sum_i b_{ij} + (\sum_i \bar{b}_{ij}/q_j)$ and declines asymptotically to $\sum_i b_{ij}$, the variable cost of a unit capacity expansion.

s: the average propensity to save in period t, exogenously given,

$Y(t) = \sum_{i=1}^{n} \sum_{\tau=0}^{t} (1 - \sum_{j=1}^{n} a_{ji})\, q_i(\tau) \left[1 - \delta_i(t - \tau)\right]$: which represent the national income in period t where $q_i(0)$ is the base-year output (or capacity) level of sector i,

$\emptyset$: a scalar (in dollars) giving the amount of net foreign capital inflow in period t, exogenously given.

(b) $Vg(t) \leq L(t)$

where

$V = (v_{ij})$: an m x n matrix of labor input coefficients per dollar's worth of output; v_{ij} is the input of labor type i required per dollar's worth of commodity j's production,

$L(t) = L(t-1) + L'(t) + L''(t)$: an m x 1 vector of (non-homogeneous) labor supplies in period t, where $L''(t)$ is an m x 1 vector of "natural" change in labor supplies (exogenous), and $L'(t)$ is an m x 1 vector of net increase in labor supplies through on-the-job labor-augmenting skill productions.

$L'(t) = U'q(t-1)$ where $U' = (u_{ij}v_{ij})$ is an m x n matrix of labor-input-training coefficients and $U = (u_{ij})$ is an m x n matrix of labor augmenting on-the-job skill training coefficients.

(c) and also subject to balance of payment constraints:

$$-\sum_{i=1}^{n} x_i(t) \leq \emptyset(t)$$

where x_i represents exports (when positive) or imports (when negative) of commodity i.

From this programming model, we will get

(1) $r_i(t)$: the shadow price for capacity rental in sector i in period t,

(2) $w_i(t)$: the shadow price for labor type i in period t,

(3) $x(t) = (I - A)\, q(t) - g(t) - d(t)$: the optimal trade pattern in period t (as a residual) where d(t) represents the demand for (private and government) consumption in period t:

$$d(t) = \bar{d} + \delta(t)d'$$

where d' is an n x 1 vector of marginal consumption propensities, $\bar{d}$ is an n x 1 vector of intercepts in the consumption demand functions, and $\delta(t)$ is a scalar representing the level of aggregate consumption in period t, $\sum_{i=1}^{n} d'_i = 1$ and $\sum_{i=1}^{n} \bar{d}_i = 0$. The linear consumption demand function for each commodity is an approximation to the constant expenditure elasticity demand function, though the approximation is close over only a limited range of aggregate consumption expenditure. A positive intercept term, $\bar{d}_i$, results in an elasticity of demand less than unity, while a negative term gives an elasticity greater than unity.

(4) q(t): the optimum sectoral production-capacity expansion in period t.

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V. TAX-CUM-SUBSIDY VIA INTUITION AND SIMPLE PARTIAL EQUILIBRIUM CALCULATIONS

1. Subsidy Based on Labor Use: The Shadow Wage Argument

One of the familiar arguments for subsidies to manufacturing industries is the argument that the industrial wage rates are too high, and do not reflect the relatively low real opportunity cost. We have to estimate the 'shadow' wage rate which will properly reflect the true cost to the economy of employing labor in industry, and which could, in principle (and, with subsidy, in practice) be used instead of actual wages to guide private entrepreneurs in deciding how many workers to employ.

Little, Scitovsky and Scott /7/ think that it is plausible to take the marginal product of labor in agriculture, which is believed to be very low, as the measure of output foregone as a result of increased industrial employment. Of course, some part of the actual wage paid to industrial workers represents a cost to society merely compensating them for the higher real cost of maintaining a given standard of living in urban surroundings.

Now, if we were to subsidize industries on the basis of shadow labor prices approximated by the marginal product of labor in the agricultural sector, the magnitude of the subsidy should be computed according to the number of "raw" unskilled labor recently transferred from agricultural sector (via urban unemployment pool), and the wages they are paid. And a very different logic should be applied if we were to subsidize the use of labor belonging to other skill group.

A very simple way to estimate the shadow price of labor, i.e.,

the marginal productivity of labor in the agricultural sector, is by assuming Cobb-Douglas production functions for value added in agricultural production. Then the marginal productivity of labor becomes the average product of labor times the Cobb-Douglas coefficient for labor (σ).

A modified 1968 I-O Table of Korea suggests 0.42 for σ in agricultural sector.[5] We now describe how we prepared Table 4.1.1. In 1971, the total value added in agriculture, forestry and fishery (simply called agricultural sector hereafter) was about 896.6 billion won. At the same time, the total labor employment was about 4.7 million. We added about 1.9 million of extra labor which represents those persons classified as "Housekeeping Non-Economically Active Population", who are mostly wives and other adult dependents of farmers.[6] Then the average value added of labor in the agricultural

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[5] The actual figure for σ in 1968 I-O Table is 0.10. But this labor share does not include all the imputed wage payment to self-employed farmers. Since the Ministry of Agriculture estimates the labor cost in total agricultural production every year, we used its estimation to modify the 1968 I-O Table.

[6] Our justification for adding 1.9 million to 4.7 million is that, in the agricultural sector, it is reasonable to regard the entire adult membership of the household as economically active farmers. The difference in types of work they are performing can more reasonably be regarded as a kind of specialization in agricultural production process. In any case, the division of labor and specialization in the agricultural sector are rather loose. Furthermore, the agricultural labor migrating to the industrial sector includes large numbers of those who are classified as "Housekeeping Non-Economically Active Population" in agriculture.

sector becomes 136,000 won a year in 1971. Applying $\sigma = 0.42$, we get 57,100 won for marginal product of labor in agricultural sector.

On the other hand, in 1971, the City of Seoul spent about 45,800 won per each economically active population in Seoul, while the local government (Do and Gun) spent about 32,000 won for each economically active agricultural populations. We took the difference between these two figures (13,800 won) to represent the extra social cost of adding the agricultural labor into the urban-industrial area.

In this fashion, we obtained 70,900 won for the shadow price of "raw" unskilled labor ("apprentices and other labor") in Korea in 1971. Although one may question the reliability of this figure, we can at least do some exercises for subsidy levels of each sector. The 1971 sectoral wage rates are from the Survey (on the firms with more than 10 employees) conducted by the Bureau of Labor.

Although the sectoral labor use would have been very different were there actually such a subsidy system, Table 4.1.1 suggests the interesting phenomenon that many labor intensive industries such as wearing apparel, furniture and fixture, transport equipment, auto repair and maintenance, and other manufacturing are already paying very low wage rates, and hence they do not seem to deserve much subsidy based on the shadow wage argument.[7]

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[7] If we examine the service sector, the wage rates for "apprentices and other labor" group which supposedly constitute the "raw" unskilled labor are mostly very high. Apparently, the apprentices in banking, trading, real estate business, etc., as presented in the Survey, can not easily be regarded as "raw" labor transferred from agricultural sector. It suggests that we need more detailed analysis to uncover some hidden features.

TABLE 4.1.1.

SUBSIDY BASED ON SHADOW WAGE RATE OF "RAW" UNSKILLED LABOR: 1971

Industrial Sector	Average Annual Wage (1,000 won)	Difference from Shadow Wage: 70.9 (1,000 won)	Number of Laborers (1,000)	Subsidy (million won)	%
Coal Mining	229.3	158.4	9.3	1,465.8	
Metal Ore Mining	207.2	136.4	3.3	453.9	
Other Mining	141.5	70.6	2.2	154.7	
Salt Mining	157.9	87.0	3.6	310.1	
Food Manufacturing	187.6	116.7	16.9	1,970.9	
Beverage Industries	154.2	83.3	8.7	721.8	
Textiles	120.8	49.9	44.7	2,232.7	
Wearing Apparel	97.2	26.3	18.4	482.5	
Lumber & Plywood	163.2	92.3	7.9	725.9	
Furniture & Fixture	95.7	24.8	2.4	58.6	
Paper & Paper Product	153.8	82.9	8.1	667.1	
Printing & Publishing	195.6	124.7	8.8	1,091.6	
Leather Products	133.6	62.7	2.6	162.6	
Rubber Products	184.4	113.5	7.7	872.8	
Basic Chemicals	227.3	156.4	3.2	495.8	
Misc. Petroleum & Coal	176.2	105.3	3.9	408.6	
Pottery Ware & China	170.6	99.7	2.1	205.3	
Other Non-Metallic	158.2	87.3	7.8	677.5	
Iron & Steel	201.5	130.6	4.4	577.[illegible]	
Fabricated Metal	110.1	39.2	12.7	499.5	
Machinery	120.8	49.9	6.3	311.8	
Electrical Machinery	139.8	68.9	11.1	762.3	
Transport Equipment	105.0	34.1	5.6	191.6	
Auto Repair & Maint.	104.0	33.1	3.6	120.6	
Precision Machinery	141.8	70.9	1.4	95.6	
Other Plastic Produc	128.1	57.2	2.1	118.1	
Other Manufacturing	99.2	28.3	12.0	338.6	
Construction	186.4	115.5	11.0	1,267.5	
Transportation	179.6	108.7	120.4	13,091.6	
Other Services	349.4	278.5	65.3	18,186.1	
				(16,171.4)**	
Total			417.0	48,719.3	

**Total excluding the service sectors.

2. Subsidy Based on Capital Use: The Shadow Interest Argument

Another argument for subsidies to industries is that, due to inefficient financial systems in developing countries, the interest rates are too high and do not reflect the shadow interest rates. In this case of factor market imperfection, one has to estimate how much too high interest rates may be.

We may try to estimate the shadow price of capital also by assuming Cobb-Douglas production function for value added in every production process. The Capital-Output ratio in Korea was about 3.0 in 1968. The share of labor and agricultural land in total value added were about 37% and 13% respectively, while business consumption and capital consumption allowance took another 3% and 5% respectively. If we regard the remaining portion, 42%, as the return to capital, we obtain a shadow interest rate of about 14%. If we add the inflation of 8% in 1968, the nominal shadow interest rate for capital use should be about 22% in 1968.

Table 4.2.1 shows the average sectoral rate of interest actually paid, the difference between the actual rate and the shadow interest rate (22%), the amount of capital fund borrowed by each sector, and the resulting subsidy magnitudes based on capital use in 1968. Of course, with the effective shadow interest rate of 22%, the sectoral use of capital fund would have been different.

Figures in Table 4.2.1 are from the Financial Statement analysis: 1970 published by the Bank of Korea, which was based on sample observation of firms with more than 10 employees. The total amount of capital

fund borrowed include bonds, foreign loans, bank loans, and private usury loans. The interest rate is the ratio of payable interest to total debt, i.e., a weithted average rate.

The Table shows that bakery & confectionery, liquor & beer, furniture, drugs & medicines, soap & cosmetics, electrical appliances, matches & clocks, business services and entertainments pay much higher rate than the shadow interest rate, but also that all other sectors, which constitute the majority in the Table, pay much lower rate than the shadow interest rate of 22%, though there is a wide range of sectoral variations.

It suggests that industries have been receiving a significant amount of subsidies, apparently not based on shadow interest arguments, in the form of low interest rates, amounting to about 22 billion won in 1968. Especially, metal ore mining, canning & preserving, flour milling, sugar refinery, raw silk, synthetic fiber, knitting mills, sawmill, printing, leather-footwear, basic chemicals, glass, iron & steel, agricultural machinery, motor vehicles & parts, electricity, construction, ocean & air transport, and foreign trade service paid less than half of the shadow interest rate.

The significant variations in the amount of interest-subsidy each sector is receiving suggest that the government is taking the second best approach. Theoretically, the factor market distortion has to be corrected directly by interest-compensating subsidies by exact amount, and the distrotion caused by other elements must be corrected by other direct subsidies. That is, the theoretically

optimal subsidy policy is to eliminate the distortion at the source itself. Furthermore, to the extent that interest-subsidies are allocated by arbitrary non-economic considerations, we shoudl expect inefficient use of available capital funds.

TABLE 4.2.1
SUBSIDY BASED ON CAPITAL USE: 1968

Industrial Sector	Actual Interest Rate	Difference from Shadow Interest Rate (22%)	Amount of Capital Fund Borrowed (million won)	Subsidy % (million won)
Coal Mining	15.46	- 6.54	8,045.0	- 526.1
Metal Ore Mining	9.82	-12.18	2,844.1	- 346.4
Other Mining	17.73	- 4.27	1,609.1	- 68.7
Dairy Products	16.23	- 5.77	104.8	- 6.0
Canning & Preserving	9.85	-12.15	544.3	- 66.1
Flour	9.21	-12.79	5,077.5	- 649.4
Bakery & Confectionery	32.23	10.23	1,199.7	122.7
Sugar Mills & Refinery	6.90	-15.10	9,325.2	-1,408.1
Soy Sauce & Bean Paste	18.57	- 3.43	389.5	- 13.4
Seasoning	19.72	- 2.28	1,146.9	- 26.1
Artificial Ice	16.91	- 5.09	267.4	- 13.6
Other Food Products	10.09	-11.91	2,648.0	- 315.4
Distilled Liquor	36.14	14.14	3,441.1	486.6
Beer	35.11	13.11	5,733.6	751.7
Sake	27.43	5.43	1,629.7	88.5
Soft Drinks	0.00	-	-	-
Other Beverages	24.82	2.82	94.7	2.7
Cotton Yarn & Fabric	19.99	- 2.01	12,685.5	- 255.0
Raw Silk	6.05	-15.95	10,488.2	-1,672.9
Woolen Yarn & Fabric	23.31	1.31	10,446.7	136.9
Synthetic Fibre	4.37	-17.63	25,447.9	-4,486.5
Weaving	11.59	-10.41	2,513.4	- 261.6

TABLE 4.2.1 (Continued)

Industrial Sector	Actual Interest Rate	Difference from Shadow Interest Rate (22%)	Amount of Capital Fund Borrowed (million won)	Subsidy % (million won)
Bleaching & Dyeing	18.68	- 3.32	1,385.2	- 46.0
Knitting Mills	8.02	-13.98	2,790.3	- 390.1
Cordag & Twine	18.48	- 3.52	759.4	- 26.7
Wearing Apparels	23.24	1.24	4,118.3	51.1
Other Textile Prod.	-	-	-	-
Sawmill	7.31	-14.69	14,956.5	-2,197.1
Furniture & Fixtures	33.56	11.56	652.5	75.4
Paper & Paper Products	30.43	8.43	7,023.7	592.1
Newspapers	27.69	5.69	1,179.6	67.1
Books	19.11	- 2.89	1,299.2	- 37.5
Commercial Printing	6.38	-15.62	1,414.3	- 221.0
Leather	20.09	- 1.91	235.2	- 4.5
Footwear (leather)	9.54	-12.46	581.0	- 72.4
Tyres & Tubes	22.60	0.60	1,902.7	11.4
Rubber Footwear	25.33	3.33	3,275.7	109.1
Other Rubber Prod.	18.49	- 3.51	365.8	- 12.8
Basic Chemicals	8.52	-13.48	1,103.7	- 148.8
Paints & Varnishes	22.11	0.11	609.5	1.0
Drugs & Medicines	50.12	28.12	3,164.2	889.8
Plastic	14.20	7.80	5,151.9	- 401.8
O[illegible] Chemicals	20.59	- 1.41	1,798.8	- 25.4
[illegible]izers	11.43	-10.57	22,078.3	-2,333.7
[illegible]um Refineries	-	-	-	-
Briquettes	11.40	10.60	1,542.2	- 163.5
Other Coal Prod.	-	-	-	-
Soap & Cosmetics	42.42	20.42	1,996.0	407.6
Cement	30.32	8.32	10,349.6	861.1
Structural Clay Prod.	19.60	- 2.40	1,551.9	- 37.2
Concrete	26.88	4.88	1,052.0	51.3
Glass & Glass Products	10.42	-11.58	2,362.4	- 273.6
Pottery & Earthen-Ware	14.22	- 7.78	912.2	- 71.0
Other Non-Metallic	16.97	- 5.03	461.3	- 23.2

TABLE 4.2.1 (Continued)

Industrial Sector	Actual Interest Rate	Difference from Shadow Interest Rate (22%)	Amount of Capital Fund Borrowed (million won)	Subsidy % (million won)
Iron & Steel	6.67	-15.33	18,093.4	-2,773.7
Non-Ferrous Metal	12.52	- 9.48	100.1	- 9.5
Fabricated Metal	25.04	3.04	2,774.7	84.4
Cutlery & Hand-Tools	23.18	1.18	755.8	9.0
Engines & Turbines	25.06	3.06	471.2	14.4
Metal & Wood Machinery	16.25	- 5.75	1,277.7	- 73.5
Agricultural Machinery	10.87	-11.13	255.0	- 28.4
Special Machinery	11.76	-10.24	1,017.3	- 104.2
Sewing Machine	27.01	5.01	190.0	9.5
Electrical Machinery	19.10	- 2.90	2,498.3	- 72.5
Communication Apparatus	25.30	3.30	1,516.0	50.0
Electrical Appliances	36.19	14.19	237.9	33.8
Electric Bulb	16.65	- 5.35	1,369.4	- 73.3
Batteries	29.51	7.51	261.7	19.7
Electric Wire & Cable	21.97	- 0.03	1,885.3	- 1.0
Other Elec. Machinery	13.25	- 8.75	77.8	- 6.8
Ship Building	15.81	- 6.19	3,218.4	- 199.2
Motor Vehicles	6.21	-15.88	6,720.0	-1,067.1
Motor Vehicle Parts	9.50	-12.50	2,471.7	- 309.0
Motorcycles & Bicycles	12.37	- 9.63	789.7	- 76.0
Other Transport Equip.	26.77	4.77	15.5	1.0
Precision Instrument	32.40	10.40	246.5	- 25.6
Matches & Clocks	49.63	27.63	594.9	164.4
Plastic Products	22.67	0.67	1,580.6	10.6
Wig	16.94	- 5.06	1,489.6	- 75.4
Musical Instruments	-	-	-	-
Office Supplies	14.95	- 7.05	219.5	- 15.5
Other Manufacturing	13.53	- 8.47	1,018.9	- 86.3
Construction	10.14	-11.86	-	-
Electricity	3.89	-18.11	-	-
Business Services	-	-	-	-

TABLE 4.2.1 (Continued)

Industrial Sector	Actual Interest Rate	Difference from Shadow Interest Rate (22%)	Amount of Capital Fund Borrowed (million won)	Subsidy % (million won)
Road Transportation	30.31	8.31	-	-
Freight Transport	11.68	-10.32	-	-
Ocean Transport	4.08	-17.92	-	-
Air Transport	8.28	-13.72	-	-
Other Water Transport	11.70	-10.30	-	-
Other	5.20	-16.80	-	-
Wholesale Trade	15.89	- 6.11	-	-
Retail Trade	19.15	- 2.85	-	-
Department Store	27.48	5.48	-	-
Foreign Trade	10.85	-11.15	-	-
Broadcasting	18.78	- 3.22	-	-
Motion Picture	-	-	-	-
Theatres	11.89	-10.11	-	-
Entertainments	50.68	28.68	-	-
Hotels	16.18	- 5.82	-	-
Other	0.61	-21.39	-	-
Total			252,902.7	-21,598.1 + 5,102.0

3. Subsidy Based on Economies of Scale under Marginal Cost Pricing

Another argument on which some quantitative light can in principle be thrown is that concerning economies of scale. The government may have to subsidize an industry, say industry A, if its expansion is to create a large enough market for, say, industry B which has increasing returns to scale, to lower its unit production cost with increased scale, and hence result in external economies.[8] Of course, it must first be supposed that B is an industry in which the country has a comparative advantage (one might use factor intensity criteria for this purpose), and also that B industry could not have realized the scale economies required by exporting, either because of significant transport and selling costs, or because foreign tariffs and quota systems ruled this out.

However, if MC-pricing could be enforced for the products from increasing returns to scale industries, then there would be no case for subsidizing other industries (industry A in the above example) on the ground that it helps the increasing returns to scale industry to achieve economies of scale. Other industries would be buying as much of the products as were desirable, and the subsidy should go directly

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[8] Suppose that the establishment of A result in an extra demand for B of 10,000 units per annum; and that this represents a 20% increase in B's output as the result of which its average unit costs will fall from $100 to $95 per unit. Then the external economy is $250,000 (assuming that A will pay, and expect to pay, $95 rather than $100), which would justify subsidy of that amount to A. Previous to the new demand, B produced 50,000 units at $100, representing a total resource use of $5 million. Now 60,000 units will be produced at $95 each, a total of $5.7 million. Thus the extra cost of 10,000 unit is $700,000. But A pays $950,000, so that there is an external economy of $250,000. This is an example given by Little, Scitovsky and Scott. [7]

to the increasing returns industry.

This MC-pricing is not only the optimum policy to eliminate the monopolistic waste of resources, but also one that can easily put into practice for most of the large scale producers, especially for publicly owned industries. However, a decreasing cost industry cannot reasonably be subsidized without the strict safeguard of price control. Otherwise a monopolistic producer may use most of the subsidy to increase profits rather than to increase his scale of operation.

Even if, by means of government control, the subsidy is fully translated into lower prices, the beneficial effect will be slight if the elasticity of demand for the product is low. That is, the demand for the product should be fairly elastic; otherwise a considerable subsidy may result in a negligible reduction in the real cost of production. This consideration is likely to make the subsidization of public utilities and non-traded goods of low priority compared to traded goods with strong economies of scale, for the elasticity of demand for these latter goods will be high in the absence of foreign quota restrictions. [7]

The principle involved may be most simply demonstrated by assuming a specific type of production function. Let it be

$$X = AL^{\sigma}K^{\delta}M^{\gamma}$$

where X denote the rate of output, L, K, M the rates of input of labor capital and intermediate materials, and σ, δ, and γ are parameters respectively.

Total cost is

$$C = wL + rK + pM$$

where w, r, and p indicate the price per unit of labor, capital and intermediate material respectively.

Assuming that each firm maximizes output for any given expenditure on factors, and that the factor prices are independent of the firm's purchases, we can obtain a new cost function

$$C = A^{*}X^{1/(\sigma+\delta+\gamma)}$$

where A^{*} is a constant depending upon the parameters of the production function and the prices of the factors. From this cost function, we get

$$e = \frac{d(AC)}{dX}\frac{X}{AC} = \frac{1}{\sigma + \delta + \gamma} - 1 \qquad \text{(AC: Average Cost)}$$

According to this formula, if we have $\sigma + \delta + \gamma = 1.1$, there will be 0.1% cost-cut for every 1% increase in total output. Now if we were to subsidize increasing returns to scale industries under MC-pricing, we may compute the "approximate" magnitude of subsidies in the following fashion.

Total Cost: $C = (AC + dAC)(X + dX)$

Total Revenue: $R = MC(X + dX)$

nder MC-pricing where $MC = \frac{(AC + dAC)(X + dX) - X(AC)}{dX} = dAC\frac{X}{dX} + (AC + dAC)$.

Let $S = \frac{R - C}{C} = \frac{1}{dX/X + 1/e}$, that is, the ratio of (negative)

profit to total cost, then

if $e = -0.1$, we get $S = 1/(dX/X - 10)$ and

if $e = -0.2$, we get $S = 1/(dX/X - 5)$, and so on.

Therefore, $e = -0.1$, for instance, justifies a subsidy of about 10% of total cost of increased output, and $e = -0.2$ about 20% subsidy, provided of course that MC- pricing is enforced effectively.

Without MC-pricing, the whole argument presented here becomes "subsidize-now" to induce the "monopolistic" or "ignorant and pessimistic" producer to expand his production scale, and "tax-later" once he realizes the monopolistic or unforeseen extra scale-profits.

J. Haldi and D. Whitcomb /3/ estimated the scale coefficients for plant capacity expansion on the basis of raw engineering data collected by industrial cost estimators and published in engineering journals. Out of total of 687 scale coefficients, 618 (90.0%) showed increasing returns, 50 (7.3%) constant returns, and only 19 (2.8%) reflected decreasing returns.[9] The scale coefficient was represented by b in $C = aX^b$, where C represents cost, X output capacity, and a is a constant.

With the same type of estimation with respect to labor and raw material cost, they conclude that in many basic industries, such as petroleum refining, primary metals, and electric power, economies of scale are found up to very large plant sizes, and that these economies occur mostly in the initial investment cost, and in operating labor cost, with no significant economies observed in raw material cost.

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[9] They argue that observation of such small number of decreasing returns cases is not surprising because, when decreasing returns set in, large units usually are not built, and instead, multiple units are used.

We now apply the production function $X = AL^{\sigma}K^{\delta}M^{\delta}$ to two-digit mining and manufacturing industries in Korea. The data are obtained from the 1968 Report on Mining and Manufacturing Census, and the four-digit sub-sectors constitute the sample observations for each two-digit industry. Hence the unit of observation is the number of employees, book value of the capital stock, and material input (in won) for a given KSIC four-digit sub-sector of a two-digit industry. That is, not only is the application to an industry level production function, but the unit of observation is also industry level. Therefore, we require the assumption that each four-digit sub-sector constitutes a single firm in a two-digit industry, operating at a specific level of homogeneous output.

We give in Table 4.3.1, the point estimates of the production coefficients (σ, δ, γ) and the scale elasticity of unit cost(e). The sum of production coefficient estimates are moderately greater than unity in ten industries out of eighteen observed. But while they suggest the presence of increasing returns to scale, their evidence is not very cogent. Thus, a hypothesis of zero elasticity of unit cost cannot be conclusively rejected--nor for that matter the hypothesis of elasticity of -0.03, -0.05, etc. It is rather pointless to speak rigorously of hypothesis rejection at specified levels of significance at this stage. None the less, the impression is unmistakable from the Table that a clear distinction must be made between increasing returns and decreasing returns to scale industries for the purpose of subsidizing the former. Our next phase of empirical implementation may involve estimation of the elasticities for four-digit industries

using the actual individual firms as basic observation units.

TABLE 4.3.1

SECTORAL SCALE ELASTICITIES OF UNIT COST (e)

1968

Sector	Production Coefficients σ(labor)	δ(capital)	ν(material)	R^2	e elasticity
Metal Mining	0.42 (0.91)	0.51 (0.90)	0.04 (0.09)	0.968 (2.22)	0.034
Non-Metallic Mining	1.02 (3.09)	0.16 (0.33)	0.55 (5.64)	0.991 (2.20)	-0.424
Food Manufacturing	-0.01 (0.21)	0.26 (3.99)	0.79 (17.83)	0.966 (2.28)	-0.034
Beverage Industry	-0.22 (2.00)	0.28 (2.48)	0.95 (11.23)	0.992 (1.36)	-0.003
Textiles	0.12 (1.43)	0.12 (2.08)	0.74 (8.07)	0.996 (1.94)	0.027
Wearing Apparel	0.48 (1.60)	-0.05 (0.48)	0.59 (2.93)	0.993 (1.72)	-0.024
Wood & Cork Product	-0.14 (0.86)	-0.03 (0.22)	1.03 (5.92)	0.999 (3.17)	0.161
Paper Products	0.22 (3.02)	0.10 (1.53)	0.82 (8.85)	0.984 (2.16)	-0.125
Printing & Publishing	0.04 (0.21)	0.16 (1.26)	0.77 (3.95)	0.991 (2.33)	0.034
Rubber Products	0.13 (0.99)	-0.10 (0.56)	0.96 (9.90)	0.997 (0.58)	0.016
Chemicals	0.12 (1.84)	0.08 (1.60)	0.86 (11.20)	0.987 (1.86)	-0.054
Non-Metallic Mineral	0.14 (3.49)	0.11 (2.31)	0.75 (14.66)	0.992 (3.20)	-0.003

TABLE 4.3.1 (Continued)

Sector	Production Coefficients σ(labor)	δ(capital)	γ(material)	R^2	e elasticity
Basic Metals	0.12 (1.10)	0.05 (0.42)	0.85 (7.40)	0.998 (1.77)	-0.010
Metal Products	0.18 (2.05)	0.15 (1.65)	0.64 (9.19)	0.987 (2.44)	0.026
Machinery	0.19 (1.20)	0.11 (0.65)	0.57 (3.21)	0.994 (2.48)	0.148
Electrical Machinery	-0.08 (0.48)	0.57 (1.64)	0.54 (2.64)	0.980 (2.17)	-0.033
Transport Equipment	0.15 (0.56)	0.30 (0.99)	0.62 (5.95)	0.989 (3.00)	-0.060
Other Manufacturing	0.08 (2.00)	0.00 (0.05)	0.88 (19.65)	0.995 (2.37)	0.032

Figures in parentheses under σ, δ, γ are t values.
Figures in parentheses under R^2 are Durbin-Watson ratios.

4. "Export" Subsidy Based on "Infant Export Industry" Argument

It is necessary to invest in cultivating an international market, and furthermore an industry breaking into a foreign market may find that, if other industries can exploit a market opened up by its own expenditures, the private returns to this activity are less than the actual social returns. This element of externality would then justify the grant of an appropriate "export subsidy" to the exportable industry.[1]

At the same time, an export-orented producer has to keep his facilities and production method up to date, cut the cost of production, and improve the product and marketing to suit the consumer tastes at home and abroad, and hence undergoes greater pressure for efficiency and quality performance. As a result, a developing country gains more valuable experienec and training effects in selling the same value of output abroad rather than at home. To the extent that this skill-training effect is external to the actual exporting industry. we may justify export subsidies. [5]

As a first approximation, we may assume that the generation of export externalities in each sector is proportional, at a diminishing rate, to incremental exports, and then distribute the available subsidy funds proportionate to the initial increase in exports. We would assume that, once the export marketing of a commodity is established, any further increase in export magnitude is rather a mechanical procedure without much learning externalities. This implies that we do not have to

subsidize the continuous expansion of exports indefinitely, as in the case of plywood exports, which seem to have had firmly established export marketing a long time ago.

Table 4.4.1 shows the plywood type (Type I) products which seem to deserve subsidies at diminishing rates to their exports. (The selection of gross output value or value added should be decided by other considerations such as the promotion of import-substitution and raising the domestic export content.)

Table 4.4.2 shows the Type II products which do not seem to have firmly established export marketing as well as an efficient domestic production system and hence deserve subsidies at non-diminishing rates to their value of exports.

Table 4.4.3 shows the the Type III products which seem to be still at infant stage in exports and domestic production, and hence require relatively large amount of subsidies to finance the initial cost of international marketing as well as the efficient production systems themselves. They were selected on the basis of: (i) the infancy of domestic production and international marketing; (ii) relatively less requirements for capital; (iii) a reasonable amount of skill required in the production process, implying some significant skill-training effects; and (iv) the existence of significant foreign markets for their exports.

TABLE 4.4.1

EXPORT SUBSIDY AT DIMINISHING RATE : TYPE I

million dollars

Sector	Exports from Korea 1962-63 Average	Exports from Korea 1966-67 Average	Exports from Korea 1970-71 Average	Korea Capital/ Labor	Japan Capital/ Labor	U.S.A. Capital/ Labor	U.S.A. Skill-Ratio	Japan Exports 1970	U.S.A. Exports 1970
Preserved Sea Foods	5.2	10.8	30.6	1		6	.03	236.8	7.7
Medical Crops	0.5	3.4	12.1	-		-	-	-	-
Lead Ores	0.3	1.7	3.2	1		21	.07	-	-
Tungsten Ores	3.2	10.3	14.1	2		29	.07	-	-
Silk Yarn	5.0	15.2	42.2	1		7	.02	-	-
Woolen & Worsted Yarn	0.3	0.8	1.9	3		7	.02	91.7	0.1
Cotton Fabrics	3.1	11.4	30.0	1		6	.02	143.3	-
Other Synthetic Fabrics	0.3	7.3	15.1	1		7	.02	608.4	-
Apparel & Accessories	2.9	22.3	118.2	1		2	.01	414.1	2.2
Other Textile Goods	0.2	11.2	38.5	2		3	.02	47.8	0.8
Bristles	0.2	19.4	85.4	1		-	-	-	-
Rubber Shoes	0.4	5.2	22.8	1		2	.01	97.7	-
Plywood	4.3	34.3	109.6	2		4	.02	72.5	1.2
Tires & Tubes	0.3	1.5	3.5	1		9	.06	159.7	-
Metal Products (Construction)	0.7	1.8	4.8	1		5	.10	373.5	80.0
Prime Movers	0.3	1.2	1.9	1		10	.09	111.1	-
Transformers	0.3	1.0	4.7	2		5	.15	169.0	4.9
Tobacco	0.1	6.6	13.8	-		10	.02	-	-
Woolen & Worsted Fabrics	0.0	3.8	3.5	1		7	.21	91.7	0.1

TABLE 4.4.1 (Continued)

million dollars

Sector	Exports from Korea 1962-63 Average	1966-67 Average	1970-71 Average	Korea Capital/ Labor	Japan Capital/ Labor	U.S.A. Capital/ Labor	U.S.A. Skill-Ratio	Japan Exports 1970	U.S.A. Exports 1970
Rayon Fabrics	0.2	3.8	2.3	1		7	.21	54.5	-
Knit Products	0.1	20.5	115.2	1		3	.02	128.3	1.2
Leather Shoes, etc.	0.0	2.4	7.9	1		3	.02	26.3	-
Ropes & Fishing Nets	0.0	3.4	11.9	1		5	.02	27.4	-
Household Electric Equipment	0.1	2.7	9.4	1		6	.15	1,087.3	37.8
Bulbs	-	1.2	2.1	1		-	-	33.1	4.8

TABLE 4.4.2
EXPORT SUBSIDY AT PROPORTIONAL RATES: TYPE II

million dollars

Sector	Exports from Korea 1962-63 Average	1966-67 Average	1970-71 Average	Korea Capital/ Labor	Japan Capital/ Labor	U.S.A. Capital/ Labor	U.S.A. Skill-Ratio	Japan Exports 1970	U.S.A. Exports 1970
Pulses	0.1	0.5	1.8	-		-	-	-	-
Processed Vegetable & Fruit	0.0	0.5	4.4	2		8	.03	12.7	-
Cotton Yarn	0.0	0.0	10.6	2		7	.02	10.0	-
Staple Fiber Yarn	0.0	0.2	2.3	8		7	.02	34.0	-
Synthetic Fiber Yarn	0.1	1.1	6.8	8		7	.02	106.3	0.4
Silk Fabrics	0.1	0.3	1.1	1		7	.02	4.5	-
Wooden Furniture	0.1	0.1	1.9	1		4	.02	34.0	-
Other Wooden Products	0.0	0.2	1.9	1		4	.02	8.6	-
Other Processed Paper	0.0	1.0	3.1	1		4	.02	10.6	-
Chemical Fibers	0.0	0.1	6.4	4		8	.04	288.3	56.4
Petroleum Products	0.0	0.0	5.8	13		21	.15	19.1	3.0
Cement	0.0	0.4	7.5	26		41	.05	28.0	-
Household Metal Products	0.0	0.7	4.5	1		9	.10	139.4	-
Synthetic Resin Products	0.0	0.7	4.4	2		6	.07	78.7	-
Steel Ingot, Sheet & Bars	0.[illegible]	0.2	17.4	1		25	.05	1,529.9	-

TABLE 4.4.2 (Continued)

million dollars

Sector	Exports from Korea 1962-63 Average	1966-67 Average	1970-71 Average	Korea Capital/ Labor	Japan Capital/ Labor	U.S.A. Capital/ Labor	U.S.A. Skill-Ratio	Japan Exports 1970	U.S.A. Exports 1970
Office & Service Machinery	0.0	0.0	4.3	1		8	.09	339.6	27.9
Electronic Machine & Parts	0.0	0.1	40.5	1		4	.15	317.2	-
Steel Shipbuilding	0.0	0.8	3.0	2		5	.12	1,452.2	2.2
Optical Instruments	0.0	0.3	1.8	1		6	.16	351.2	4.5
Musical Instruments	0.0	0.2	1.8	1		4	.07	57.3	-
Toys & Sports Goods	0.0	1.1	5.9	1		4	.07	258.5	40.2

TABLE 4.4.3
EXPORT SUBSIDY AT HIGH INFANT RATES: TYPE III

million dollars

Sector	Exports from Korea 1962-63 Average	1966-67 Average	1970-71 Average	Korea Capital/ Labor	Japan Capital/ Labor	U.S.A. Capital/ Labor	U.S.A. Skill-Ratio	Japan Exports 1970	U.S.A. Exports 1970
Fixed Vegetable Oils, soft	0.0	0.0	0.0	2		19	.03	7.0	..
Synthetic Organic Dyestuffs	0.0	0.0	0.1	3		13	.11	14.7	..
Pigments, Paints, Varnishes	0.0	0.1	0.0	1		13	.11	12.7	..
Glassware	0.1	0.3	0.5	1		10	.05	19.4	12.4
Pottery	0.1	0.1	0.1	1		2	.05	119.3	..
Tubes, Pipes, Fittings(Steel)	0.2	0.3	1.0	2		20	.05	334.6	..
Metal Containers(Storage)	0.0	0.1	0.3	1		5	.10	7.2	..
Wire Product, Fencing Grille	0.1	0.1	1.9	1		10	.10	66.4	4.3
Nails, Screws, Nuts, Bolts	0.0	0.0	0.1	1		8	.10	94.3	..
Tools for Hand or Machine	0.0	0.3	0.4	1		6	.10	60.8	0.9
Cutlery	0.0	0.6	4.4	1		14	.10	86.1	..
Agricultural Machinery	0.0	0.1	0.2	1		10	.09	63.8	..
Metalworking Machinery	0.0	0.1	0.3	1		7	.09	88.5	..
Textile & Leather Machine	0.1	1.4	1.1	1		5	.09	261.4	53.0
Machny. & Applian. switchgear	0.3	0.8	1.6	1		7	.09	625.6	542.5
Electric Power Machinery	0.3	1.0	4.0	2		7	.15	269.2	..
Equip. for Distrb. Elect.	0.0	0.1	0.2	3		5	.15	116.9	..

TABLE 4.4.3 (Continued)

million dollars

Sector	Exports from Korea 1962-63 Average	Exports from Korea 1966-67 Average	Exports from Korea 1970-71 Average	Korea Capital/ Labor	Japan Capital/ Labor	U.S.A. Capital/ Labor	U.S.A. Skill-Ratio	Japan Exports 1970	U.S.A. Exports 1970
Railway Vehicles	0.0	0.0	0.1	2		8	.12	44.0	-
Road Motor Vehicles	1.2	0.7	1.6	2		12	.12	1,590.8	-
Road Vehicles, nonmotor	0.0	0.1	0.3	1		3	.12	36.2	-
Ships & Boats	0.0	0.7	2.8	2		5	.12	1,424.6	-

Capital per Labor (unit: $1,000; 1963) and Skill Ratio (1960) for U.S.A. are based on data developed by G.C. Hufbauer /4/, especially Table A-2. There are quite a few cases of arbitrary extrapolation from a similar commodity group. Skill ratios refer to the percentage of the industry's labor force accounted for, in the U.S., by professional, technical, and scientific personnel.

5. Subsidy Based on Externalized On-the-Job Skill Production

(a) McKinnon's Argument: Entrepreneurial Skill Production Approximated by Profit Rates

R. McKinnon argues that, in a fragmented world, high learning is better correlated with high profit rates than with any other economic indices, such as cumulative investment or current output, which purport to take external effects into account. /97 There are entrepreneurs with information and the opportunities to exploit technological gaps in the way existing resources are employed as compared to best-practice techniques in advanced economies. Since there are many firms with a wide variety of production techniques, all producing the similar outputs, there will be external spin-offs when these other entrepreneurs copy innovators, which will be shown up as higher profits there, and so on. One may then conclude that the rate of profit within individual enterprises is as good as any single measure of the learning externalities.

If, as McKinnon argues, learning externalities are positively correlated with the rate of profit rather than levels of output, --assuming, this is a big assumption, the absence of tariffs or other distortions in the commodity markets--then the government policy in dealing with one phase of learning is enormously simplified. The channeling of government subsidy funds to high rate-of-return activities (proportional to their profit rates) automatically identifies and subsidizes the learning process.

(b) Skill-Production Externalities Approximated by Productivity Change

Another possible (still very crude) way to measure externalized skill production is to measure the increase in productivity of the industry because the increase in productivity is partly the result of technical innovation and partly the improvement in labor skills working for the industry. If we can assume that skill-production externalities are proportional to internal productivity change in each industry, we may distribute the subsidy funds accordingly.

(c) Subsidy Based on Direct Measurement of Externalized On-the-Job Skill Production

If we were to subsidize each industry on the basis of actual skill-training externalities, we first have to examine the generality of the skill which the labor acquires in the production process and the mobility of the labor among different industries. Secondly, we have to measure the approximate magnitude of such skill production on the job in each industry.

6. Subsidy Based on Its Contribution to Sectoral Increase in Value Added

We may try to measure the impact of changes in subsidy policies on sectoral value added and national income in the following fash' First, we try to measure the sectoral subsidy elasticity of value added either by simple regression of time-series data or by simple partial equilibrium formula assuming, say, a Cobb-Douglas type function for value added, and then, we may measure the secondary impact on value added using input-output relationships.

Of course this partial equilibrium approach, and for that matter, any partial equilibrium approaches, does not incorporate induced changes in the price of primary factors and non-tradable commodities, nor do they permit unambiguous forecasts if major changes in subsidies to a number of sectors are being contemplated simultaneously. Furthermore, if we carry those partial equilibrium calculations to far, we will be in danger of excessive double counting.

7. "Externality" Subsidy Based on Measurement of Production Functions

The differences between the internal increasing returns to scale of each individual firm in an industry and those of the industry itself, as well as the differences between the internal increasing returns to scale of each industry and those of the entire economy, can be used as the index for (and a device to measure) the sum of external economies generated by each individual firm, operating all together, in each industry, as well as the sum of external economies generated by each industry, operating all together, in the entire national economy.

In order to measure the individual firm's contribution to the sum total of external economies and the optimum magnitude of subsidies to each firm, we may compare the observed production function for each individual production process in the real economy (which would already include external effects), and its engineering production function. If the returns to scale in the observed production function exceeds those of the engineering production function, the excess (in terms of output value) should be taxed away and given to the other producer, and the same procedure should be applied to the other producer.[10]

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[10] An immediate objection raised by Professor I. Adelman against this approach was that engineering production functions usually show greater increasing returns to scale than observed production functions, suggesting external diseconomies only, if any.

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서울특별시동대문구청량리동산 1 의 182

電話 (97) 1671~3 (96) 0161~3

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