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"COMPARATIVE STUDIES OF RESOURCE ALLOCATION AND DEVELOPMENT POLICY"

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Progress Report: June 1, 1967 - November 30, 1967

A.I.D. Contract CSD 1543

Harvard University

"COMPARATIVE STUDIES OF RESOURCE ALLOCATION AND DEVELOPMENT POLICY"

Progress Report, A.I.D. Contract CSD 1543

June 1, 1967 - November 30, 1967.

This report briefly describes research undertaken at Harvard University in conjunction with A.I.D. Contract CSD 1543 on "Comparative Studies of Resource Allocation and Development Policy." This project began formally on June 1, 1967, although some of the early substantive work and preparatory contract expenditures began on April 5, 1967. Progress is indicated through November 1967, with the exception of the financial data, which were available only through September 1967.

The substantive outline in Section I roughly parallels the original research proposal; however, it should be noted that a number of projects fall under several different categories and hence the specific classification is somewhat arbitrary. In the first section, both past progress and future research intentions are reported. (Since this was generally a period of "tooling-up", there are few final research products to be presented at this time). Section II indicates the senior research personnel who have worked on the project, plus a preliminary summary of expenditures. The rather large appendix contains a number of working papers which have been prepared by staff members during the past six months. These reports are submitted for general information only, and, except as otherwise noted, are to be regarded as preliminary drafts still subject to considerable change.

I. Substantive Progress

A. AGRICULTURE

a) Agricultural-Industrial Interrelationships:

Much of the agricultural work of the past six months has focused on India and Pakistan. Within this general area, Walter Falcon completed a study on "Agricultural and Industrial Relationships in West Pakistan."* The major focus of this paper was on the way in which agriculture has been "squeezed" for development purposes. For the analytical portions of the study, a highly disaggregated input-output table emphasizing agriculture was developed. Using this table, the study provided empirical estimates of the flows from industry to agriculture and vice versa. It also indicated the importance of small-scale industry in assessing sectoral interactions.

b) Livestock:

In West Pakistan, the livestock subsector of the economy still contributes more to GNP than does combined large- and small-scale manufacturing. This fact is all the more startling given how very little is known about the livestock economy. During the summer, Carl Gotsch and Peter Timmer completed an extensive study entitled "A Consistent Estimate of the Animal-Product Contribution to GDP in West Pakistan."* In particular, they re-estimated the national accounts, which earlier work had shown to be very dubious. Of considerable importance was their finding that the rate of growth in livestock had been seriously underestimated (approximately 4% per annum vs. 2%

* An asterisk indicates that the study is among the working papers included in the Appendix.

given by official data). This work also identified several parameters where additional survey data on livestock appear to be critical.

c) Intra-Provincial Growth:

Although considerable attention has been given to the income disparity issue between East and West Pakistan, there has been almost no analysis of intra-Provincial disparities. Since the Pakistan Constitution also calls for the elimination of the latter, Carl Gotsch's paper, "Regional Agricultural Growth: The Case of West Pakistan."* is an important first step in this area. In particular, this study indicates the role of irrigation-water availability as a factor in the differential growth, and the severe difficulties that face the low-rainfall areas of West Pakistan. It also indicates the importance of the efficiency/equity dilemma facing irrigation planners in West Pakistan. Gotsch expects to further refine and expand this study during the next six months.

d) Rural Works:

The Rural Works Program of East Pakistan is usually cited as the largest and most successful program utilizing under- and unemployed resources in a labor-surplus economy. Both the political and economic effects of this program are alleged to have been important in East Pakistan's recent development. In an effort to assess these effects more specifically, John Thomas spent five months of 1967 in Pakistan. During this time he supervised the interviewing of over 800 individuals. (Copies of the various interview schedules are included in the Appendix). During the next six months he will analyze these data and begin writing up the results. He will be specifically

concerned with such questions as the effects of the program on transportation costs, rural employment and wage rates; on the administrative processes that were developed for decentralized action; etc.,

e) IADP in India:

The recent agricultural lag in the Indian economy has been so critical to the development process that studies on the rural sector seem particularly important at this time. In recent months, Dorris Brown has been analyzing the role and effectiveness of the Intensive Agricultural District Program in India. His preliminary analysis of the program in Punjab, ("The Intensive Agricultural Districts Programme and Agricultural Development in Punjab, India"*) indicates that the program seems to have made relatively little difference in the growth of agricultural output in Ludhiana district -- at least as compared with growth in adjoining districts where the program was not in effect. In the months ahead, Brown expects to test similar hypotheses for other Indian States where paddy is the dominant crop to determine whether his Punjab conclusions hold for other regions in India as well. Throughout this study he will be primarily concerned with the forces that have impeded agricultural development in India and the steps necessary to counteract them.

f) Programming Models:

Some of the most sophisticated water-planning techniques applied anywhere have been used to analyze the irrigation problems of West Pakistan. In "A Programming Approach to Agricultural Policy Planning"*, Carl Gotsch has built upon these models and has illustrated the methodological usefulness of optimizing models for addressing matters of agricultural policy. This paper also provides specific quantitative insights into the

employment effects created by the investment in new technology; the effect of the tubewells on the price elasticity of supply for agricultural commodities; the proper mixture of public and private investment in irrigation facilities, etc. His results underscore the profound influence that the tubewell program is having on the agricultural development of West Pakistan.

g) Future Plans:

In addition to the future plans noted above, work on several other projects is anticipated in the months ahead. Morton Grossman and Walter Falcon expect to collaborate on a paper dealing with P.L. 480 commodities and their role in a buffer-stock policy for India. Carl Gotsch expects to spend December 1967 and January 1968 in West Pakistan and India in preparation for a comparative essay on East and West Punjab. For the much longer run (2 years), Walter Falcon has begun work with Bruce Johnston and Stephen Lewis on a book entitled "The Economic Determinants of Agricultural Development." The book will focus on agricultural and industrial interrelationships and will deal with three basic models -- those of Japan, the U.S.S.R., and Mexico. The analysis will also be concerned with how these three models were, or are, being applied in Taiwan, Argentina, Pakistan, Ghana, Colombia and Kenya.

B. TRANSPORTATION.

During the past six months, the transportation research program has pursued work along several fronts.

a) Project Analyzer:

The need for a means to analyze transport proposals on a project basis without the expense of a complete economic simulation stimulated the development of a "Project Analyzer". The Project Analyzer has

been designed to evaluate the effects of changes in a transport network on the cost and performance of the network when the systems analysis provided by the complete economic model cannot be afforded or justified. It consists of the technological sub-routines (for highway, railroad and transfer) and other routines from the larger model already developed, combined with routines written specifically for the Project Analyzer. Input to the Project Analyzer consists of a description of a transport link and a traffic volume specification for the various classes of traffic which will flow over the link. The operation of the link is then simulated and a summary of the public and private cost for operating the link is printed out followed by the present value of that time stream of costs.

The Project Analyzer is a new analytical tool which promises to provide a powerful means for appraising alternative transport systems. Royce Ginn and Donald Dewees began to implement the Analyzer's use in Colombia by taking the program deck and sample output to Bogotá, studying the available computers, and outlining the steps necessary to permit Colombians to operate it on their computers. A smaller Project-Analyzer program written by Robert Burns in Bogotá has already been run successfully on a Colombian computer.

b) Commodity Transport:

Since August, Clell Harral has been conducting a study of the cost of transporting commodities by various transport modes, particularly road and railroad, with reference to the costs and technology which exist in eastern India. Subsequently the significance of these findings

for planning, regulatory, and pricing policies in the Indian transport sector will be examined. For the highway analysis, operating cost data have been produced from actual factor costs and capital construction costs observed in India, using technical relationships which are found in the United States. Alternative vehicle sizes and highway design standards were examined and the lowest cost technology chosen in this exercise to establish the long run marginal cost of highway transport. A similar analysis is being made for the railroads. Emphasis in this study has been on the determination of the complete social costs associated with transit time, uncertainty of delivery, and risk of loss or damage of goods in transit. Adjustments are made to account for divergencies between "social" and "private" costs in matters such as indirect taxes, the opportunity costs of capital and foreign exchange. The relationships resulting from the foregoing analysis will be synthesized to produce guidelines demonstrating when it is advantageous to choose railroads and when highways.

c) Macroeconomic Simulation Model:

During the past six months, David Kresge has produced a draft based on a macroeconomic model which is compatible with, and an integral part of, the transportation routines being developed. The paper, ("A Simulation Model for Economic Planning"*) describes the operation of the model and the manner in which it was calibrated to represent Pakistan. It demonstrates that the calibration was sufficiently close to justify use of the technique for investigating several economic policy alternatives. A number of runs were described and their results analyzed to project the policy implications and conclusions which are possible with this type of model.

d) Mahlon Straszheim is currently working on the editing and revising of a study on project analysis and techniques in transportation planning. The overall study is concerned with costing, pricing, capital budgeting, demand forecasting and investment analysis techniques as they presently exist. Also included are relatively new methods for analysis under conditions of uncertainty using Bayesian statistical methods. Straszheim expects to continue work on this project for the next several months.

e) Future Plans:

Much of the next several months will be spent in expanding and refining (a) and (b) above. Writeups of the Project Analyzer and the commodity transport studies are planned, and it is also expected that the analyzer will be tested on a variety of actual cases. In addition, Paul Roberts expects to begin work on a general study of highway construction costs. This project will quantify the various technical relationships in construction, and will be designed in such a way as to take into account varying factor costs in different countries.

C. EDUCATION AND MANPOWER

In the education and manpower area, work centered on the relationship between education and growth and on educational planning models.

a) Educational Planning Models:

During the contract period, Samuel Bowles continued to work on educational planning models. This work, which has been done within a linear programming

framework, pays specific attention to the "production" technology of the educational system. Bowles has nearly completed a first draft of a book on this subject (Planning Education for Economic Growth) which analyzes educational planning in Nigeria, Greece, Canada and several other countries. Bowles' major conclusions are that (i) different educational planning models yield radically different resource allocation prescriptions; (ii) relatively minor changes in educational techniques can produce major increases in the efficiency of the educational system; and (iii) in the northern region of Nigeria most intensively studied, efficient resource allocation calls for putting more resources into the educational system and for distributing those resources within the system away from secondary education towards primary education. Bowles expects to complete this monograph during the next year.

b) Education and Growth:

Marcelo Selowsky, who has recently joined the Quantitative Project staff from the University of Chicago, continued his work on "Education and Economic Growth: Some International Comparisons"*. The study is concerned with both the theoretical and empirical aspects of this relationship, with much of the analysis concentrating on Chile (1940-64), Mexico (1940-64), and India (1950-60). Selowsky concludes that earlier studies have understated the contribution of education to growth because they have not included the contribution of holding constant the amount of education per head. When this adjustment is made, he concludes that for Chile and Mexico almost one fourth of the growth rate is explained by education. His other major conclusion is

that a comparison of the factor endowment of countries suggests that the main differences between developed and less developed countries is not in the amount of physical capital per laborer but in the amount of educational capital per laborer.

Selowsky expects to extend this work in the months ahead, with particular emphasis on the extent to which different qualities of education can substitute for each other and for conventional forms of capital.

c) Obsolescence and Learning:

During the Summer of 1967, Samuel Bowles began work on the age dimension of the supply of human capital and on related consequences for the rates of growth of a country's GNP. ("Obsolescence, Deterioration and Learning"*). Using data from the United States, Greece and India, he weighs the relative effects of obsolescence and physical deterioration through time with that of "learning by doing". Using a vintage capital approach, plus data on age-earning profiles, labor force participation rates and mortality rates, Bowles concludes that the net effect of aging on the human capital stock ranges from very small negative (Greece) to rather high positive (India). He also concludes that in the cases studied, learning seems to outweigh obsolescence by a considerable amount. Bowles expects to extend this study to other countries, and to examine such hypotheses as (i) do most countries which have experienced a recent and rapid expansion of education, e.g., Ghana and India, experience aging effects on human capital which are strongly positive? and (ii) as countries reach demographic maturity, do the effects of aging act as a decelerator of economic growth?

D. COUNTRY STUDIES.

In addition to the sectoral studies mentioned above, work has also progressed on a number of broader country analyses.

a) Pakistan:

The question of regional growth and equity between East and West Pakistan was examined extensively by Joseph Stern ("National and Regional Growth: The Case of Pakistan"). Stern uses aggregative regional models within a programming framework to examine the consequences of achieving the constitutional proviso of equal per capita incomes by 1985 (assuming also a termination of foreign aid by that date). He concludes that the achievement of such regional equality would be costly in terms of national income foregone -- so costly, in fact, that both regions would be richer absolutely if this goal were abandoned, (i.e., if West Pakistan were allowed to grow uninhibited and equality were achieved by income transfers). He suggests a reformulation of the equity goal and argues for an equal growth rate objective rather than one of equal income. Building on the above aggregative analysis, Stern also examines the sectoral consequences of these various objectives with detailed input-output tables for the two regions. He concludes that the implications for West Pakistan agriculture of an equal income objective are particularly distressing since they seem to imply a "necessary" deceleration of regional growth in this sector. In the months ahead, Stern expects to extend this work -- particularly on the policy measures which can help reduce the disparity -- and to prepare this study for publication as a monograph.

b) Greece:

"The Sources of Greek Growth 1951-1961"* were analyzed by Samuel Bowles. Specifically, the study attempted to identify the inputs which might explain the growth in GNP, with particular emphasis on the contribution of education. Bowles' major conclusions were that (i) there was a larger-than-usual contribution from capital which was directly related to the high rate of investment; and (ii) that the contribution from increased schooling of the labor force was relatively small in Greece, largely due to the poor correlation between increased productivity and additional schooling. The Greek case therefore presents an interesting contrast to a number of other countries, particularly those recently analyzed by Edward Dennison.

c) India:

As noted in the original proposal, the studies on India by Morton Grossman, although separately financed, have been considered an integral part of the research at Harvard. During the past year in India and Cambridge, Grossman has been working on several policy papers on liberalization for the Indian Government and on a study entitled: Indian Economic Planning, Programs and Policies: Forced Development under Conditions of Shortages and Uncertainties. The papers on liberalization analyze the impact of successive reductions in internal licensing and price controls and also of devaluation and partial import liberalization upon economic efficiency, resource allocation, future income, savings and the balance of payments. Grossman concludes that the gains accruing from liberalization have been limited thus far, largely because of current economic conditions, and may

be constrained in the future because of continuing foreign exchange problems and the lack of concomitant tax, tariff, import competition, export incentive and price policies. The larger study noted above examines in detail planning and operations of the Indian economy which have been under severe structural constraints for the past decade. The effects of the planning-control system upon Plan formulation and consistency, project analysis and implementation, management and operation of the economy are analyzed. In addition, the partial steps toward internal and external liberalization of allocation and price controls are explored. The major focus of the study is on the near and longer term planning, program and policy considerations facing India currently as it recovers from a food-price inflation and industrial recession with additional current and investment resources required for both agricultural and industrial development. Grossman will continue work on this project after a short visit to India and expects to have a draft for circulation by July 1968.

d) Korea:

David Cole and Larry Westphal have worked extensively on Korean problems (both in Cambridge and Seoul) during the past six months. Cole's analysis of the rapid growth of the Korean economy is reported in "Inflation, Stabilization and Growth in Korea"*. Of particular interest is his discussion of the somewhat unorthodox way in which Korea has broken several of the key development constraints: an emphasis on export expansion rather than import substitution, on private savings (through higher interest rates) rather than public savings and on the use of non-governmental foreign financing. Cole expects to expand this analysis and to collaborate with Princeton Lyman on a monograph dealing with both the economic and political aspects of Korea's recent development.

Westphal and Cole have also worked on optimizing and projection models for the Korean economy. Building on the Chenery/Westphal model (discussed later), Westphal will examine optimal levels of investment in Korea for the next decade. Of particular interest will be investments in iron/steel and petrochemicals -- investments characterized by their lumpiness and economies of scale. Preliminary thinking on this model is indicated in "An Inter-Temporal, Multi-Sectoral Optimizing Model for Investment Planning in the Republic of Korea"*.

Cole and Alan Semansky have also worked out revisions in the computer programs for the Korean sectoral Projection model, originally developed by Marshall Wood at the National Bureau of Standards, ("On the Utility of Inter-industry Projection Models"*). These revisions are intended to make the model much more flexible and useful for the ongoing planning needs of the Korean government and the AID mission in Korea. It should also facilitate a comparison of results obtained from using a projection model and an optimizing model. Such comparisons on a number of specific issues are expected during the next year.

e) Colombia:

Building upon his previous field experience and writings, Richard Bird has begun a book on the relationship between tax structure and economic development in Colombia. A major focus of this work is on the means for obtaining public resources from the modern sector without stifling its growth and development. Among other topics which Bird discusses are (i) the relationship between tax structure and economic objectives, (ii) an analytical history of public finance in Colombia, (iii) the effect of income distribution

on the pattern of demand and foreign trade, and (iv) the role of local government. Bird's major aim is to suggest a set of tax and expenditure policies which can operate efficiently within the political and administrative constraints of Colombia. He expects to have a draft of the book for circulation within the next several months.

f) Argentina:

Richard Mallon, who has just recently returned to Cambridge from Latin America, has begun work on a quantitative history of economic policy in Argentina. Mallon expects to focus on the most recent 15 years, although some of the analysis will predate this period. He will be particularly concerned with questions of inflation/stabilization and on the effects of changes in the terms of trade between agriculture and industry. Mallon expects to develop and use extensively the national accounts for Argentina, and for this portion of the study he will be working closely with former colleagues at Di Tella Institute. (This portion of the work will be financed separately). Mallon foresees this as a longer-run project which will occupy much of his time during the next year.

E. INDUSTRIALIZATION AND STRUCTURAL CHANGE.

a) Patterns of Structural Change

The aim of the structural change study has been to uncover systematic relationships across countries and over time between the size and growth of the producing sectors of underdeveloped economies (e.g. primary production, manufacturing at both the aggregate and two-digit levels, and output of the service sector) and such explanatory variables as per capita income, population, and

factors influencing international trade. There have been two major sub-projects in the overall study.

Lance Taylor has undertaken an analysis of the patterns of change in the three aggregate producing sectors -- primary production, manufacturing, and services -- using post-1950 data for about fifty countries. One of the main conclusions of this study is that countries with populations above and below 15-20 million have shown significant differences in the evolution of their manufacturing sectors; large countries in cross-section show a declining elasticity of manufacturing value added with respect to per capita income while small countries show an approximately constant elasticity. Despite the differences in elasticities, the share of manufacturing in total output in small countries lies below that of large. This is generally due to the greater importance of primary production and exports in the smaller countries. Taylor also concluded that the cross-sectional changes in manufacturing and primary value added are "paralleled" in a general way by time series changes since 1950, although there is considerable variation in the time series elasticities of value added with respect to per capita income about the cross-sectional "norm". Taylor expects to expand this study during the next six months and to prepare it for final publication.

Hollis Chenery, (assisted by Moises Syrquin, Armin Claus, and Lorene Yap) has been working with recent United Nations cross-sectional data for value added at the two-digit level. Preliminary analysis suggest that the sectors show considerable variation in the elasticities of growth with respect to per capita income. Chenery has concluded that deviations from a log linear relationship between value added and income are most

significant in trade-oriented sectors. Preliminary work has also been completed on a large simulation model which uses an 18-sector input-output table to "predict" structural changes in the producing sectors as a function of changes in final demand components. When cross-sectional regressions are used in turn to predict the final demand components as functions of income, the resulting predictions of production changes seem to show considerable parallelism with the cross-sectional regressions for value added. Work in this area will be continued during the next year and will form a part of a book by Chenery on the Patterns of Economic Development.

b) Argentine Industrial Policy:

Since September 1, David Felix has been working on problems of industrial structure in Argentina. (Felix is also separately financed, but the study is directly related to work under the contract). His major focus is on the question, How does a country with a high cost, under-utilized, tariff protected and fragmented industry, rationalize its industrial policy? Felix has also been analyzing the development of industrialization ideology in Argentina. Both of these topics are discussed in preliminary fashion in "Some Notes on Implementation of Argentine Industrial Policy"*. During the rest of the academic year Felix expects to expand these notes, and to examine industrial concentration in Argentina through the use of the 1953 and 1963 industrial censuses.

c) Location of Pakistan Industry:

Why industrial entrepreneurs locate in particular regions is an often-debated subject on which there is relatively little research for the less developed world. Pakistan is a rather unique laboratory in this regard, since at the time of

Partition in 1947 it had very little industry. By use of an extensive industrial survey, Gustav Papanek was able to trace the major factors that went into "The Location of Industry in Pakistan"*. Included in this study is an assessment of the reasons for the extraordinary growth of Karachi (which in an earlier period had less of industry than Dacca) and an evaluation of cost differentials by region. Perhaps of most significance, however, is Papanek's finding that, in terms of total capital invested, "personal preference" and the location of government exceeded such other reasons as location of markets, infrastructure facilities, etc. in determining plant location. Papanek is in the process of revising this essay for inclusion in a volume of essays on the economy of Pakistan which he is editing.

F. AID AND TRADE.

a) Aid Bargaining:

Lester Gordon has been actively engaged in research on the aid bargaining process. Included in this analysis is a review of the foreign press of Brazil (1963-4), Colombia (1966-7), India (1965-6), Chile (1962-5), and Korea (1964-66) to determine the public image of, and political reactions to, the negotiations. He is also examining the economic aspects of the issues under negotiation and the bargaining strategies of the participants. Gordon expects to continue the above work during the course of the next year and he also hopes to develop an aid negotiating "game" for training purposes.

b) Aid Strategy:

Because of the increasing concern about foreign aid -- particularly its availability relative to

the need -- a working group has been recently formed at Harvard University within the Kennedy Institute. Lester Gordon will serve as executive secretary to this group which will also include a half-dozen other staff members whose research is supported under the AID contract. During the course of the next year, these individuals are likely to produce several documents on the "aid" question growing out of the scheduled seminar series. Although these documents will not be the product of the AID contract per se, they will be so closely linked to ongoing work under the contract that they will be reported in this and succeeding progress reports.

In an earlier study this year, Gustav Papanek has offered several suggestions on "Changes in Aid Strategy"*. He argues against the proliferation of multilateral agencies (such as regional banks) and suggests that in the short-run, the uses of "harder" credit and debt rollover are both inevitable and desirable. For the longer run, Papanek places great emphasis on international monetary reform and increased international liquidity.

c) Export Promotion:

Three studies are currently underway on the problems of export promotion.

Khalid Ikram, under the general supervision of Gustav Papanek, has just initiated a study on Pakistan's export performance between 1950 and 1967. Of particular interest in this analysis will be the policies which changed the stagnant export position in the 1950's to a situation of rapid growth in the 1960's. Among the specific topics to be studied are foreign versus domestic demands for internationally traded goods; the operation and success of the export bonus scheme; the role of export duties; the role of state trading and bilateral arrangements, etc. Ikram expects to spend much of the next year on this analysis.

Daniel Schydrowsky has been especially interested in the problems of expanding exports in semi-industrialized countries which have significant amounts of underutilized capacity. In "Short-Run Employment Policy in Semi-Industrialized Economies"*, Schydrowsky uses Argentina as a case study for analyzing such a situation. He argues for export subsidies to stimulate the demand necessary for activating industry and for supplying the imports indispensable for its sustained operation. Using both Keynesian and linear-programming models, he estimates that subsidies in Argentina of up to 130 percent of the f.o.b. value of exports might be justified in terms of their impact on the fiscal balance. Schydrowsky is presently refining this analysis for journal publication.

In Colombia, the export problem has become especially critical because of the relative decline of coffee earnings. In "Policies to Promote Colombian Exports of Manufactures"*, Richard Mallon and Antonio Urdinola discuss various means and institutional arrangements which could promote manufactured exports to cover the estimated \$300 million gap in 1970 between coffee earnings and import requirements. Within this study, they analyze various export incentives, particularly those given under LAFTA and Plan Vallejo. The latter they regard as being particularly significant in the recent growth of foreign exchange earnings and a promising technique for the future.

d) Future Plans:

In addition to the ongoing work noted above, Daniel Schydrowsky expects to develop further his work on effective rates of protection during the next six months. Schydrowsky also plans to complete work on the theory and measurement of an appropriate shadow price for foreign exchange.

Some preliminary notes on this subject are included in his "On the Choice of a Shadow Price for Foreign Exchange"*.

G. PLANNING MODELS AND TECHNIQUES.

a) Planning Models Involving Economies of Scale:

Earlier work on investment planning by Hollis Chenery and Larry Westphal has been refined and expanded during the past summer in "Economies of Scale and Investment Over Time"*. In this paper, they are particularly concerned with large investments which are likely to produce such significant changes in an economy to invalidate usual partial analyses. Using mixed integer programming techniques and a variety of experimental runs, they conclude that the timing of investment in scale-economy sectors has a substantial effect on the timing in other sectors and hence on the whole investment pattern. Moreover, they also conclude that in a rapidly growing economy the timing of investment may be far more important than the choice of sectors along static comparative advantage lines.

In a related development, David Kendrick has produced a new computer algorithm for solving the above type of problem. ("Branch and Bound Algorithms for Investment Planning Problems"*). As noted in the Chenery/Westphal paper, the original optimizing program was very time-consuming on the computer. The new Kendrick technique appears to be faster by a factor of six, resulting in substantial economies and permitting a much greater potential for applied use of similar investment programming models.

b) Non-Linear Planning Models:

If national planning models are to incorporate the continuing work on the estimation of production,

export, and import functions, economists must be able to solve non-linear models. Research by David Kendrick and Lance Taylor during the last few months has been directed toward formulating and solving these types of models. ("A Non-Linear Multisectoral Planning Model"* and "Numerical Analysis of Economic Planning Models"*). Conjugate gradient and neighborhood extremal methods have been programmed and used on models with two control variables and two state variables. Work is underway at present on the specification and solution of more complex models. For this purpose, the Korean data and models described earlier are being used.

H. SUMMARY.

For ease of expository and discussion purposes, the foregoing discussion has been on an individual project and paper basis. This approach has the disadvantage, however, of underplaying the interconnected nature of the research -- a point on which a few comments seem in order. First, it is clear that the research has mainly concentrated on a relatively small number of key countries -- Pakistan, India, Korea, Greece, Argentina and Colombia. And it can also be said quite unequivocally that the various pieces of research have fed each other enormously in this work. Second, most of the research has been either on policy questions directly, or on analyses which underlie key policy decisions. Third, the advantages of a field-Cambridge approach that were stressed heavily in the original approach are indeed being realized. Requests about key policy areas from DAS and AID field projects are increasing in number, as is the reverse flow of new techniques and analyses going to the field. To cite but two examples: (i) the project analyzer for Colombia in the transport area, and (ii) the investment planning models in the case of Korea. (The latter is a particularly interesting case since theoretical development by Chenery and Westphal were reinforced by the development of improved computational

techniques by Kendrick which now are being used by Cole and Westphal in their field and policy-oriented analyses of Korean investment problems). Finally, it should be stressed that a considerable amount of the integrative writing per se will occur more towards the end of the project. Much of the work of the first six months has been devoted to the individual country and sectoral analyses which will form the basis of later comparative work.

II. Personnel and Expenditures

Table I indicates the senior personnel whose research work has been supported under the contract. (The listing is somewhat complicated by the fact that the six months in question cover portions of three work periods at Harvard: academic year 1966/67; summer 1967; and academic year 1967/68). It indicates that the total senior-research commitment has been approximately 11 man-months during the pre-contract period and about 54 man-months for the first six months of the contract. This 8-month total of 65 man-months -- of which about 52 were financed directly from AID funds -- compares with the original estimate of about 48 man-months for a comparable period.

Expenditure data through September 30, 1967 are given in Table II. The pattern is roughly the same as that indicated for the man-month data. As of September 30th, i.e., at the end of 4 months plus the pre-contract period of 2 months, \$144,653, or about 25% of the eighteen months' allocation of \$577,882 had been spent. (These numbers are approximate magnitudes and are for general information only. They are "unofficial and tentative" pending final tabulation by Harvard's Office of Research Contracts). The line items correspond very closely to those contained in the budget for the first six months, with the exception of computer expense, which is running below the budgeted level.

All indications are, therefore, that the project is running on schedule, or perhaps even slightly ahead of that indicated in the original proposal.


Walter P. Falcon,
Cambridge, Massachusetts,
November 28th, 1967.

TABLE I.

SENIOR RESEARCH PERSONNEL

April 5 through November 30, 1967

NAME	APPROXIMATE PORTION OF TIME COMMITTED		
	April 5-June 30	July 1-August 31	Sept 1-Nov. 30
Richard Bird	38%	50%	38%
Samuel Bowles	25%	50%	50%
Dorris Brown	100%	100%	100%
Hollis Chenery	25%*	50%*	
David Cole	75%	40%	75%
Walter Falcon	50%	75%	50%
David Felix	-	-	75%*
Lester Gordon	25%	25%	25%
Carl Gotsch	50%	100%	75%
Morton Grossman	75%*	75%*	75%*
David Kendrick	25%	100%	25%
David Kresge	-	25%	-
Richard Mallon	-	-	50%
John Meyer	10%*	10%*	10%*
Gustav Papanek	25%	33%	33%
Paul Roberts	-	-	17%
Daniel Schydrowsky	25%*	-	25%*
Marcelo Selowsky	-	-	50%
Joseph Stern	-	100%#	50%
Mahlon Straszheim	-	-	17%
Lance Taylor	-	100%#	50%
John Thomas	25%	75%	75%
TOTAL MAN-MONTHS	(17; of which 11 were in April, May and 6 in June)	(20)	(28)

*Salary separately financed.

#Paid as Research Assistant pending Faculty appointment in September, 1967.

TABLE II.

EXPENDITURES, April 5 - September 30, 1967.

	<u>April 5-May 31</u>	<u>June 1-Sept. 30</u>	<u>Total</u>
Senior Research Staff	\$11,413.81	\$ 35,966.15	\$ 47,379.96
Research Assistants	4,094.13	35,281.27	39,375.40
Secretaries, Clerical Staff	5,400.03	6,446.65	11,846.68
Computer Use	1,900.34	4,891.66	6,792.00
Supplies, Telephone, Postage, etc.	2,063.67	4,169.59	6,233.26
Travel	-	506.75	506.75
Subtotal	<u>24,871.98</u>	<u>87,262.07</u>	<u>112,134.05</u>
Overhead	7,212.88	25,306.00	32,518.88
TOTAL	<u>\$32,084.86</u>	<u>\$112,568.07</u>	<u>\$144,652.93</u>