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9. ABSTRACT

This study provides a consistent mulisectoral framework to analyze and project sectoral output and employment and the resulting sectoral and personal income distribution. Part I describes the macroeconomic and sectoral structure of Colombia for the 1950-67 period in terms of output, employment and income distribution. Part II projects these variables to 1980 within a consistent framework and under different assumptions regarding export growth and technological change.

The most noteworthy findings were that unemployment is likely to increase significantly in Colombia and the income distribution to beoome more uneven. The maintenance of the productive and technological structure existing im the base period is likely to alter the sectoral output mix in such a way as to worsen the employment and income distribution. Technological change in agriculture may result in a small decline in absolute employment but in a less uneven income distribution than that obtained without technological change.

The results of the study are compared with the "idealized" strategy which ILO formulated for Colombia. The ILO estimates of the growth rate of GDP and of labor productivity are generally higher than those obtained from the consistency framework analysis.

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A CONSISTENCY FRAMEWORK FOR EMPLOYMENT OUTPUT AND INCOME DISTRIBUTION PROJECTIONS APPLIED TO COLOMBIA*

by

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*Paper prepared for the Development Research Center of the International Bank for reconstruction and Development. January 1972.

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Introduction: Scope of the Study and Outline of the Analytical Framework

The purpose of this study is to design a consistent multisectoral framework to analyze and project sectoral output and employment and the resulting sectoral and personal income distributions.

The study is divided into two major parts. The first part attempts to describe quantitatively the macroeconomic and sectoral structure of the Colombian economy over the period 1950-1967 in terms of output, employment and income distribution. The second part projects these variables to 1980 within a consistent framework and under different assumptions regarding export growth and technological change.

Part I entailed the following steps. The first step consisted in building a macroeconometric model of Colombia over the period 1950-1967. This model proved capable of explaining accurately the macroeconomic structure and performance of the Colombian economy over the sample period. The model itself determines the paths of the endogenous variables consisting of gross domestic product, consumption, investment and imports as functions of exogenous variables such as exports, changes in the terms-of-trade and public expenditures.

The second step consisted of obtaining input-output and employment information on a comparable basis within a 10-12 sector breakdown. From the above information it proved possible to derive the sectoral income distribution and to design a methodology which provided a mapping between the sectoral and personal income distributions prevailing in the mid-sixties.

The second part of the study is devoted to the design of an analytical framework capable of generating a set of internally consistent projections to 1980. First, projections of the major macroeconomic variables are undertaken

within the context of the macroeconomic model mentioned above under two alternative assumptions regarding exports and public expenditure variables. (i.e., "high" and "low" growth alternative) Next, the various components of sectoral final demand are projected in a way consistent with the macroeconomic projections. Thus, for example, final demand consumption for the various sectors is computed as a function of GDP growth given likely values of the sectoral income elasticities of consumption demand. Likewise, the sums of the sectoral final demand components (i.e., consumption, changes in stocks, investment, exports and imports) is consistent with, namely add up, to the projected values of the variable appearing in the macroeconomic model. (See Figure I)

Thirdly, the sectoral gross output and value added vectors were projected to 1980 given projected final demand and the consolidated input-output table of 1966. Furthermore, on the basis of magnitudes of the growth rates of labor productivity by sector likely to prevail over the projection period, the sectoral employment and income distributions were derived. The methodology designed in Part I is then used to map the personal income distribution resulting from the sectoral distribution. At that stage, it can be determined whether the changes in the composition of output and employment affected the personal income distribution. To the extent that changes in the latter were projected to prevail in 1980, revised projections of the final demand components (specifically consumption of agricultural and manufacturing goods) were undertaken to insure consistency with the new income distribution.

In addition, a fairly rudimentary test was conducted to check whether the alternative output combinations resulting from the projections to 1980 could be produced given the total investment funds generated by the macroeconomic model. It was determined that the investment availability would not constrain the attainment of the projected sectoral output and value added combinations reached

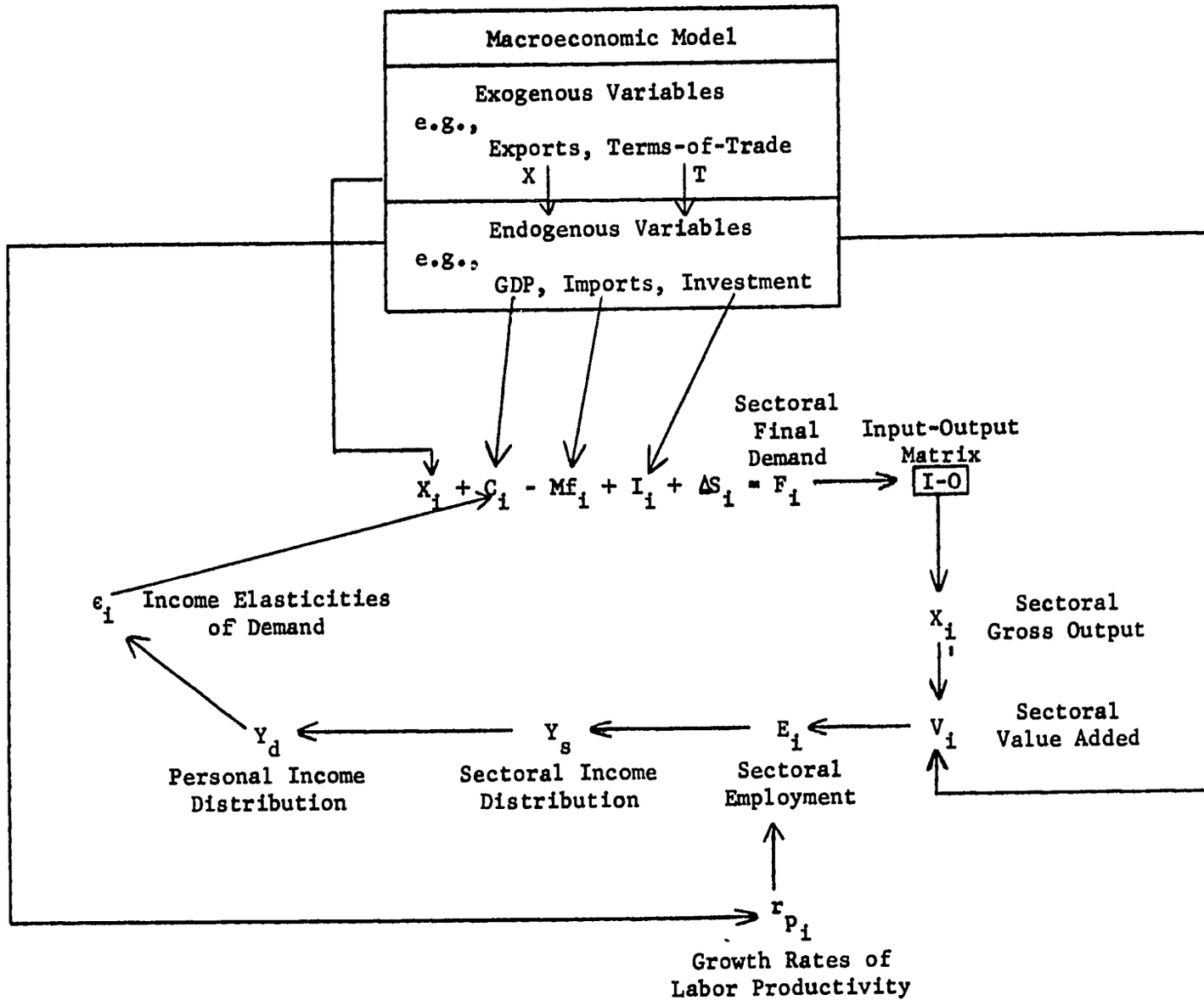
under the two growth alternatives.

The whole set of projections described above reflects the likely consequences of a maintenance of the productive structure of the Colombian economy since the input-output matrix prevailing in the base-year (1966) was used to generate these projections. The value of these projections for policy purposes is that they may provide the policymaker with a quantitative view of the consequences of essentially neutral technological policies.

The final section of Part II is devoted to a simple analysis of the effects of technological changes in agriculture on employment and income distribution.

Figure I presents in a schematic form the analytical framework of the study.

Figure I. Analytical Scheme of Study



Part I. Colombia: Output Employment and Income Distribution, 1950-1967

1. Present Economic Policy Setting in Colombia: Background and Rationale for Colombian Study

Employment creation and a more even income distribution have become two major--if not the foremost--policy objectives of the present Colombian government. The National Development Plan for 1969-72 [4] states explicitly that the "generation of remunerative employment creation must be the principal objective of any development program--given the present situation of the country". [4, p. 2]

In 1969 President Lleras Restrepo invited officially the International Labor Office to send a mission to Colombia to undertake an in-depth study of the unemployment problem and make policy recommendations to improve the employment prospects. A team of more than twenty experts under the direction of Dudley Seers visited Colombia and prepared their report which appeared in 1970 [3] The primary and explicit purpose of the report, as its title indicates, was to recommend a "full employment" strategy. Defining full employment as 95 percent of the labor force and given the demographic trends, it would necessitate the creation of about 5 million additional jobs between 1970 and 1985. It was felt that the maximum productive labor absorption which could occur within agriculture would be of the order of 1.8 percent annually (equivalent to about half the

natural increase in the rural population). This would mean that over the fifteen year planning horizon, agriculture could only provide about 750,000 new jobs and that, therefore, the non-agricultural sectors would have to absorb the remaining 4,250,000 additional slots. The achievement of this objective, in turn, would require a growth rate of employment outside of agriculture of 7 percent per year.

A hypothetical "idealized" strategy is designed, which is summarized in Table 1, to reach this employment target. Three non-agricultural sectors are defined: (1) a capital-intensive, skill-intensive sector including modern manufacturing, mining, public services and transports; (2) an essentially labor-intensive (i.e., non-capital-, nor skill-intensive) sector consisting of construction, artisanal production, trade and personal services; and (3) a skill-intensive sector which embraces financial and government services. Table 1 illustrates clearly the basic aspects of the strategy. The rate of growth of labor productivity would be increasing in agriculture from the present level (2.0 percent) to 3.5 percent per annum, while it would decline in the rest of the economy. These changes would occur while at the same time GDP would grow at 8.0 percent a year (5.4 percent in agriculture and 8.9 percent in non-agriculture). This strategy would, thus, entail major changes in the composition of output towards relatively more labor-intensive goods and services and in technology away from capital-intensive techniques - at least, outside of agriculture. It would amount to "progressive modernization" from the "bottom up". The reduction of the rate of growth of labor productivity could only take place if more reliance were placed on traditional and newly designed labor-intensive techniques befitting Colombia's resource endowment better than "modern" techniques.

In agriculture, on the other hand, the increase in the growth of labor productivity suggests that relatively more capital-intensive techniques are to be

Table I. Colombia: Growth Rates of Employment, Labor Productivity and Value Added by Sector: Estimates for 1964-70 and Hypothetical Strategy for 1970-85 (annual cumulative growth rates in percentages).

	Employment		Labor Productivity		Value Added	
	1964-1970	1970-1985	1964-1970	1970-1985	1964-1970	1970-1985
Sector:						
Agriculture[1/]	1.4	1.8	2.0	3.5	3.4	5.4
Nonagriculture	3.2	7.0	2.5	1.8	5.7	8.9
of which:						
Capital-intensive and Skill-intensive[2/]	2.5	6.9	4.0	2.9	6.6	9.1
Not capital-intensive nor skill-intensive[3/]	3.6	6.9	1.4	1.5	5.1	8.5
Skill-intensive[4/]	3.3	8.3	1.8	1.0	5.1	9.3
All Sectors	2.3	4.8	2.9	3.2	5.2	8.1

1/ Agriculture, livestock, forestry and fishing.

2/ Mining, modern manufacturing, public services and transportation.

3/ Construction, artisanal production, trade and personal services.

4/ Financial and government services.

Source: [3, p. 61]

used. It is, probably, consistent with the need for irrigation facilities to cultivate new land areas, the increased use and high yields of intermediate capital inputs (e.g., fertilizer, insecticides, improved seeds) and perhaps some selective mechanization.

The ILO strategy would necessitate the implementation of major structural changes, as well as agrarian reforms, a removal or reduction in the artificial distortions in factor prices, fiscal reforms and limiting consumption expenditures of the higher and middle-income classes, the design of entirely new (labor-intensive) techniques of production, and policies conducive to altering the composition of output. In any case, the ILO strategy should be considered as a set of general guidelines to achieve full employment by 1985, rather than a specific and detailed plan.

It is interesting to note that a continuation of the present trends - assuming the structure of the economy to remain the same during the projection period - would result, according to the Mission, in a level of unemployment of between 31 and 37 percent of the labor force in 1985 (compared with 21 percent in 1970). [3, p. 406] A "passive" policy would have disastrous consequences and, hence, drastic changes are called for.

Even though many of the assumptions made (mostly implicitly) on the supply and demand sides appear reasonable on a priori grounds, no I-O consistency check is undertaken. Furthermore, assumptions regarding sectoral growth rates of labor productivity appear rather arbitrary, e.g., an increase in the latter rate in agriculture from a present 2.0 percent per annum to 3.5 percent over the projection period (1970-85) and a reduction from 4.0 to 2.9 percent in manufacturing.

In the light of these considerations, a general equilibrium consistency check appears essential which is undertaken in the subsequent sections.

2. Macroeconomic Models of Colombia

a. Review of Existing Models

In projecting the major macroeconomic variables (and particularly GNP), it is important to be able to rely on a macroeconomic model. There exist at least three such models for Colombia. The first one by Kanta Marwah [2] is a detailed economometric model (containing 44 equations) and estimated over the period 1951-62. Its principal purpose is to analyze the effects of devaluation. A number of the relationships are somewhat synthetic--mainly because of the data limitations which forced the author to use various proxy variables.

A second model which is both much simpler and more recent is the one used to prepare the National Development Plan [4, Ch. I, pp. 53-4]. The model contains six equations explaining respectively, consumption, disposable income, private investment, imports, changes in stocks and GDP. The main exogenous variables are--in addition to lagged values of the above--public investment and consumption, exports, changes in prices and the rate of exchange. Thus, in solving the model simultaneously the rate of growth of GDP can be expressed exclusively as a function of the above exogenous variables. In other words, GDP can be projected given assumed values of these exogenous variables. The design of this model and its specification in terms of current prices limit its usefulness to only short-run projections.

A third macroeconomic model which was estimated, essentially, over the period 1950-65 is that of Rodaro Noriega and Villodres Tena [6]. The authors attempted to estimate a large number of relationships between variables expressed, in some cases, at current and in other cases at constant prices. Out of the large set of estimated equations, the authors selected the most

reasonable ones on theoretical and statistical grounds. The resulting model is, however, of limited use for projection purposes since it contains a substantial number of exogenous variables which are very difficult to forecast in the long-run.

In addition to these models the ILO Mission used a simple quantitative method to project GDP and ultimately employment for the four sectors mentioned above. The procedure which was followed was to divide Investment into two parts: (a) machinery and equipment, and (b) construction. The former was estimated as a function of exports (including net inflow of foreign capital) and terms-of-trade, while capital formation in construction was simply lagged on itself [4, pp. 404]. Two statistically significant relations were obtained by least-squares and used to project future investment--mainly as a function of exports. The next step was to postulate incremental capital output ratios for the four sectors and compute the resulting growth rates of sectoral output. Finally, to obtain the growth rates of sectoral employment the above rates are corrected for changes in labor productivity.

In the absence of an appropriate model for projection purposes, it was felt necessary to construct a simple macroeconomic model which is presented in the next section.

b. A Simple Macroeconometric Model of Colombia

Many alternative specifications were designed and estimated before finally settling on the simple model presented in Table 2.[*/] Two major requirements dictated the choice and design of the model. First, the model had to explain

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[*/] More than 100 regressions were run in an attempt at obtaining theoretically and statistically significant functions explaining, respectively, consumption, imports and investment and their components over the period 1950-1967.

Table 2. Macroeconomic Model of Colombia* (OLS Estimates)

1. $Cp_t = -875.41 + 0.8148\bar{Y}_{t-1}$ $\quad \bar{R}^2 = 0.9849$
$\quad (-1.5541) \quad (32.2785)_{**}$ $\quad DW = 1.9507$

2. $M_t = -4436.0430 + 0.1782Y_t + 3966.6943\bar{T}_t + 0.6222\bar{R}_{t-1}$ $\quad \bar{R}^2 = 0.9334$
$\quad (-3.0643)_{**} \quad (6.4331)_{**} \quad (4.5622)_{**} \quad (1.5603)$ $\quad DW = 2.5211$

3. $Ip_t^* = 1246.9731 + 0.3778(\bar{Y}_{t-1} - \bar{Y}_{t-2}) + 0.4114M_t$ $\quad \bar{R}^2 = 0.7254$
$\quad (3.4857)_{**} \quad (2.1635)_{*} \quad (4.5844)_{**}$ $\quad DW = 1.6436$

4. $Y_t = Cp_t + \bar{Cg}_t + I_t + \bar{E}_t - M_t$

5. $I_t = Ip_t^* + \bar{Ig}_t + \overline{\Delta S}_t$

Endogenous Variables: Cp_t, M_t, Ip_t^*, Y_t, I_t

Exogenous Variables: $\bar{Cg}_t$, $\bar{E}_t$, $\bar{T}_t$, $\bar{R}_{t-1}$, $\bar{Y}_{t-1}$, $\bar{Y}_{t-2}$, $\bar{Ig}_t$, $\overline{\Delta S}_t$

*The model was estimated on the basis of annual observations expressed at constant (1958) prices over the period from 1950 to 1967. The t ratios are given in parentheses under the coefficients. One star and two stars, respectively, denote significance at the 5% and 1% levels. The list of variables is given on the next page. Exogenous variables are identified by a bar above the symbol. The model was also estimated by Two-Stage Least-Squares (TSLS). The TSLS estimates which are given in Table A.1 of Appendix A are very close to the OLS estimates.

Table 2 (cont.) **List of Variables**

All variables are expressed in millions of constant (1958) pesos. The time subscripts indicate, respectively, current (year t), and lagged (t-1 and t-2) values.

Endogenous Variables

Y_t = Gross Domestic Product

Cp_t = Private Consumption

M_t = Imports of Goods and Services

I_t = Gross Investment

Ip_t^* = Gross Private Investment

Exogenous Variables

$\overline{Cg}_t$ = Government Consumption

$\overline{E}_t$ = Exports of Goods and Services

$\overline{T}_t$ = Terms-of-Trade Index (the ratio of export prices to import prices with base year 1958 = 100)

$\overline{R}_{t-1}$ = Level of Foreign Exchange Reserves Lagged one year

$\overline{Y}_{t-1}$ = Gross Domestic Product Lagged one year

$\overline{Y}_{t-2}$ = Gross Domestic Product Lagged two years

$\overline{Ig}_t$ = Government Investment

$\overline{\Delta S}_t$ = Changes in Stocks

accurately the macroeconomic performance of the Colombian economy over the sample period (1950-1967), and, secondly, it was to lend itself to the generation of projections.

The model consists of three behavioral and two identity relationships. Consumption is explained by lagged GDP; imports are expressed as a function of current GDP, the terms-of-trade and the lagged level of foreign exchange reserves; and private investment is generated by the change in GDP lagged one year and current imports. The two identities define, respectively, GDP and gross investment in terms of their components.

The model is of the accelerator-multiplier type. Private investment is influenced by the capacity to import and the past growth of income. The main exogenous variables can be broken down in three types: (a) foreign sector variables (exports, foreign exchange and terms-of-trade); (b) public sector variables (government consumption and investment); and (c) lagged endogenous variables (lagged GDP).*/ The performance of GDP is greatly influenced by the above foreign sector variables and particularly by exports. It should be noted that the model, as such, does not contain a production function linking the growth of GDP to cumulative investment or the stock of capital. This is a particularly serious drawback when the model is to be used for long-run projection purposes. Consequently, to remedy this shortcoming certain simple sectoral production relationships between cumulative investment and sectoral GDP are specified and applied to check the feasibility of projection alternatives generated by the model from the standpoint of the availability of investment. (See section II. 7)

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*/ The only remaining exogenous variable, i.e., changes in stocks, can be considered essentially stochastic--although partially explained by the level of GDP.

The model was estimated by one-stage least-squares (OLS) on the basis of annual observations from the official national income accounts expressed at constant (1958) prices spanning the period 1950 to 1967.*/

c. Test of the Predictive Ability of the Model

Before using the model for projection purposes, its predictive ability over the sample period (1950-1967) was tested. The first step in such a test is to derive the reduced form of the model by expressing the set of endogenous variables exclusively as a function of the set of exogenous variables (including the lagged endogenous variables) and the constant terms.

In symbols let:

A = the coefficient matrix of the endogenous variables.

y = the vector of endogenous variables.

B = the coefficient matrix of the exogenous variables (including the lagged endogenous variables).

x = the vector of exogenous variables.

c = the vector of constant terms.

The estimated model in Table 2 can be expressed as:

(1) $-Ay + Bx + c = 0$

The reduced form of this model is:

(2) $y = A^{-1}Bx + A^{-1}c$

The matrix $A^{-1}B$ is the matrix of impact multipliers linking the exogenous variables to the endogenous variables. Table A.2 in the Appendix gives the matrix of impact multipliers.

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*/The model was also estimated on the basis of two-stage least-squares (See Table A.1 in Appendix). Since the differences between the OLS and TSLS estimates were very small, it was decided to use the OLS estimates for projection purposes.

The second step, after having derived the reduced form, consists of substituting the actual values of the exogenous variables into equation (2) above and obtaining the predicted values of the set of endogenous variables (the $\hat{y}$'s) for each year of the sample period. The final step is to compare the values of the predicted endogenous variables with the actual observed values of the endogenous variables (the y's).

The above procedure was followed and the results were plotted in Figures A-E in Appendix A. It can be seen that the model predicts relatively well the changes in the endogenous variables. It is relevant to note that the model does reasonably well in predicting turning points for imports and the investment variables (see Figures C-E).

Another more stringent test of the predictive ability of the model over the sample period was performed. This test consisted of substituting the values of lagged GDP ($\hat{Y}_{t-1}$ and $\hat{Y}_{t-2}$) generated by the model instead of the observed values to obtain the predicted set of endogenous variables. The results of this test were, likewise, reproduced graphically in Figures F-J which reveal that the model predicts GDP (see Figure F) very well and the other endogenous variables reasonably well. This last test was essential in judging the accuracy of the model in generating the income path from the base period. Indeed, when the model is used for projection purposes outside the sample period, it should be capable of generating the income path accurately, since the lagged values of GDP are themselves unknown.

In conclusion, the tests which were performed on the model indicate that it has a relatively high explanatory power over the sample period--with a large number of computed (predicted) values being close to the observed values for the set of endogenous variables.

3. Input-Output Information for Colombia

There is only limited input-output information available on Colombia. The first attempt at building an I-O table for Colombia was undertaken by ECLA and referred to the year 1953. Since the reliability of the coefficients appear relatively low and the information is outdated no use shall be made of that early table.

The second attempt at building an I-O table is still underway. It is being done by the Planning Department (Planeacion) with the assistance of the Harvard Development Advisory Service. What is available so far is a 31 sector I-O table of 1966 [5] broken down in five primary sectors, eighteen industrial sectors and five tertiary sectors. Value added is subdivided between wages and salaries and other value added (i.e., principally income on capital). Imports of intermediate goods (raw materials and primary goods) appear as a row. Thus value added for any given sector is obtained by subtracting intermediate inputs and intermediate imports from gross production. Unfortunately, at this time, the final demand vector is not broken down into its components. A detailed description of the procedure used to build the I-O table is given in [5] and judging from the writeup the quality of the table is high.

As a first step, we attempted to consolidate the above I-O table into ten sectors and to construct the final demand matrix, i.e., distribute sectoral final demand into its major components. In order to achieve the latter a number of assumptions had to be made which are indicated in the explanatory table and note to Table which gives the resulting ten sector I-O table.*/ In addition,

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*/The 31 sector I-O table given in [5] does not contain a Housing Rent sector. Since the value added of this sector is relatively large in the national income accounts, it was incorporated in our ten sector I-O Table. It should be noted that the lack of information precluded obtaining the corresponding intermediate demand and input coefficients. Consequently, it was assumed that the gross output of the "Housing Rent" sector was equal to value added. This is not an overly unrealistic assumption for that sector.

Table 3. Input-Output Table for Colombia, 1966 (in millions of 1966 pesos at market prices).*/

Sectors	Coffee (1)	Agriculture (2)	Mining (3)	Manufacturing (4)	Construction (5)	Transportation and Communication (6)	Utilities (7)	Finance (8)	Services and Commerce (9)
(1) Coffee	0	0	0	2,109	0	0	0	0	0
(2) Agriculture	0	983	12	2,645	22	6	0	0	0
(3) Mining	0	1	0	871	145	13	31	0	0
(4) Manufacturing	50	1,057	37	7,271	1,995	1,890	70	162	0
(5) Construction	0	0	0	0	0	0	0	0	0
(6) Transportation & Communication	6	252	54	2,044	93	111	25	301	0
(7) Utilities	0	7	6	341	55	37	105	104	0
(8) Finance	28	332	9	637	103	91	17	30	0
(9) Services & Commerce	2	403	64	1,825	292	498	62	524	0
(10) Housing & Rent	0	0	0	0	0	0	0	0	0
(11) Total Intermediate Inputs	86	3,035	182	17,743	2,705	2,646	310	1,121	0
(12) Total Value Added (V_i)	3,073	17,196	1,469	11,854	2,867	5,182	950	2,708	20,902
(13) Value Added in Labor Income	10,135		898	4,742	2,586	3,114	489	1,855	12,260
(14) Value Added in Non-Labor Income	10,135		571	7,112	281	2,068	461	853	8,642
(15) Imports of Intermediate goods (Mi_i)	0	86	60	4,648	60	138	9	0	0
(16) Gross Output	3,159	20,317	1,711	34,245	5,632	7,966	1,269	3,829	20,902

*/ See Table B.1 and explanatory note in Appendix B regarding the breakdown of final demand components.

(Continued)

Table 3. (Continued)

Sectors	Services and Commerce (9)	Housing and Rent (10)	Total Intermediate Demand (11)	Final Demand (F_i^*) (12)	Exports (E_i) (13)	Imports of Final Goods (Mf_i) (14)	Capital Formation (I_i^*) (15)	Consumption and Changes in Stocks ($C_i + \Delta S_i$) (16)	Gross Demand (17)
(1) Coffee	0	0	2,109	1,050	1,050	0	0	0	3,159
(2) Agriculture	0	0	3,668	16,649	700	0	70	15,879	20,319
(3) Mining	0	0	1,061	650	650	0	0	0	1,711
(4) Manufacturing	0	0	12,532	21,713	4,076	4,745	4,113	18,269	34,245
(5) Construction	0	0	0	5,632	0	0	5,632	0	5,632
(6) Transportation & Communication	0	0	2,886	5,080	868	566	0	4,778	7,966
(7) Utilities	0	0	655	614	0	0	0	614	1,269
(8) Finance	0	0	1,247	2,582	0	0	0	2,582	3,829
(9) Services & Commerce	0	0	3,670	17,232	1,204	531	1,981	14,578	20,902
(10) Housing & Rent	0	0	0	4,174	0	0	0	4,174	4,174
(11) Total Intermediate Inputs	0	0	27,828	75,376	8,548	5,842	11,796	60,874	
(12) Total Value Added (V_i)	20,902	4,174							
(13) Value Added in Labor Income	12,260	0							
(14) Value Added in Non-Labor Income	8,642	4,174							
(15) Imports of Intermediate goods (Mi_i)	0	0							
(16) Gross Output	20,902	4,174							

the breakdown of value added into wage and non-wage income was altered in the consolidated table (Table 3) as compared to the original 31 sector matrix. It was felt that the latter tended to underestimate wages and salaries--as the national income accounts do--by not including imputed labor income of the self-employed/employer group. This question has been discussed in detail by Slighton [7] where an attempt was made to compute imputed labor income for the nonagricultural sectors and add it to wage income. We applied the percentage of sectoral value added calculated in [7] for 1964 to our 1966 figures--assuming that no significant change had taken place between these two years. For agriculture, we assumed--somewhat arbitrarily--that half of value added represents wages and imputed labor income. (It should be remembered that non-labor income includes in addition to capital rentals, capital consumption allowances and indirect taxes.) Berry [1] estimates the labor share of value added to have fallen from about 60 to 40 percent in Colombian agriculture between 1935 to 1965. However, he uses a somewhat restrictive definition of labor share (that is, the pure labor share not including any return to human capital).

The interindustry (A) and the $(I-A)^{-1}$ matrices for 1966 were computed and are given in Tables B.2 and B.3 in Appendix B.

4. Income Distribution and Employment

a. Empirical Evidence on Income Distribution

It is clear that both the sectoral and personal income distributions are directly linked with the employment pattern (e.g., the distribution of the economically active population (EAP) by sectors, the extent of unemployment and underemployment and the wage rate). The seriousness of the un- and underemployment problem has already been discussed in section I.1. However, since an important part of our consistency approach will be concerned with the measurement of the sectoral employment effects and the consequences of the latter on sectoral and, ultimately, personal income distribution, it is

essential to analyze the present state of income distribution and build a bridge between the latter and employment.

The various studies of income distribution in Colombia are consistent in revealing the existence of a very, and increasingly, uneven personal income distribution. The ILO report [3, Ch. 10] devotes a whole chapter to reviewing the main estimates of income distribution by respectively Taylor (1962), ECLA (1962, and Musgrave (1964). Since then an additional study [10] has come out based on 1964 data which corroborates the results obtained by Musgrave as can be seen from Table 4. The fact that the methods and procedures used by these two studies were quite different increases the degree of reliability which can be placed in these figures. It can be seen that there is a substantial agreement between the two distributions, e.g., half the individuals received only about 14 percent of total income and 90 percent of the individuals received about half the total income. The only difference appears at the highest income levels; the results of the first distribution indicating that 5 percent of the individuals received 40 percent of income and in the second case 35 percent. (This difference is further accentuated at the top of the income pyramid where one percent of the individuals received 26 percent of the income according to the Musgrave report and 15 percent according to Urrutia-Villalba).

International comparisons of the degree of inequality in income distribution reveal that it is relatively very high in Colombia. Using the Lorenz coefficient (or some approximation of it) ECLA [8] concluded that the concentration of income in Colombia was higher than in any other Latin American country for which income distribution statistics existed. (The coefficient of income concentration for Colombia in 1964 was 0.57 which compared with Brazil (0.57), Mexico (0.53), U.K. (0.40), U.S. (0.40) and Norway (0.36).

Table 4. Colombia: Two Distributions of Personal Income.

Cumulative Percentage of Individuals	Cumulative Percentage Income	
	Musgrave	Urrutia-Villalba
50	14.0	13.5
60	20.0	19.0
70	26.0	26.5
80	35.0	36.5
90	50.0	52.0
95	60.0	65.0
100	100.0	100.0

Source [10, p. 6]

The evidence indicates rather strongly that the income distribution has become more uneven--at least--in the last two decades. Slighton, who focussed on non-agriculture, shows conclusively that this increased inequality has resulted from the "combined effect of an increase in the unemployment rate and an increase in the wage differential between subsectors of the economy characterized by changing technology and subsectors where technology is static"

It is also pointed out that the growth rate of employment was lower in the modern subsectors than in the traditional ones during the period 1951-64. The annual rate of growth of real wages averaged between 4.0 and 4.5 percent in the modern sectors of the nonagricultural economy while the equivalent rate for the traditional sectors was probably zero over the same period. Thus, according to Slighton, nearly three-fourths of all workers (including agriculture) were employed in the mid-sixties in activities where the real wage probably did not increase at more than half a percent annually over 1951-1964. There is no strong evidence that the situation has changed in the last few years.

There is some evidence that the distribution of income in the rural areas is more uneven than in the urban areas, the greatest disparities occurring in the top decile of the income pyramid. (According to [10] the top decile of the rural population received 51 percent of the rural income in 1964, while the top decile of the urban population received only 40.5 percent of urban income.) Berry [1] computed the income distribution in agriculture for 1960. His conclusions are consistent with the preceding findings. In applying Berry's distribution to total agricultural income for 1966, the average per capita income resulting for the lower half of the agricultural population (540 pesos) was slightly below the value of the subsistence diet which appears impossible. Consequently, a more reasonable income distribution--substantially less unequal than that derived by Berry--was postulated below (see Table 9).

b. A Possible Mapping between Sectoral and Personal Income Distribution

Since a consistency model used for projection purposes would yield sectoral value added and employment figures and thereby provide an estimate of the sectoral income distribution, it is essential to try to build a methodological and empirical bridge between the latter and the personal income distribution. A knowledge of the personal income distribution is required to estimate the sensitivity of the income elasticity of demand for domestic goods and imports to changes in the degree of concentration of income.

The approach which was followed was, first, to allocate value added by sector between labor and non-labor income. This distribution was done on the basis of Slighton's work [7] where total wage income including imputed labor income of employers and self-employed was calculated for a number of non-agricultural sectors for 1964. The respective percentages of labor and non-labor income to value added which obtained 1964 were applied to the 1966 sectoral value added totals for the non-agricultural sectors. (In the case of agriculture, it was assumed that half of value added consisted of labor income.)

The second step was to estimate the economically active population (EAP) by sector in 1966 and derive some estimates of sectoral value added by member of the EAP. Table 5 summarizes the above information. It should be noted that the sectoral breakdown in that table coincides with that of the consolidated I-O table given in Table 3. However, a subsectoral breakdown is given for the "Service and Commerce" sector. Given the size and the heterogeneity of this sector, it appeared important to divide it into the following four subsectors: commerce, personal services, craft manufacturing, and government services for which value added figures are available from the national income accounts. An examination of the last row of Table 5 reveals the significant differences which

Table 5. Colombia: Distribution of Value Added Between Labor and Non-Labor Income by Sector and Sectoral Employment (1966).*/

	Coffee	Agriculture	Mining	Manufacturing	Construction	Transportation and Communication
Value Added (in millions of 1966 pesos)	3,073	17,196	1,469	11,854	2,867	5,182
	20,269					
Value Added Percentage in Labor Income	50		61.1	40.0	90.2	60.1
Value Added Percentage in Non-Labor Income	50		38.9	60.0	9.8	39.9
Economically Active Population (x 1,000)	2,507		80	300	239	204
						Trans. 188 / Comm. 16
Value Added in Labor Income (in millions of 1966 pesos)	10,135		898	4,742	2,586	3,114
Value Added in Non-Labor Income (in millions of 1966 pesos)	10,135		571	7,112	281	2,068
Value Added in Labor Income / EAP (in thousands of 1966 pesos)	4.04		11.22	15.81	10.82	15.27

*/ Source: see text.

(Continued)

Table 5. Colombia: (Continued)

	Utilities	Finance	Commerce	Personal Services	Craft Industry	Govt. Services	Housing Rent	Total
Value Added (in millions of 1966 pesos)	950	2,708	7,888	5,183	3,763	4,076	4,174	70,375
Value Added Percentage in Labor Income	51.5	68.5	44.7	55.5	47.4	100	-	
Value Added Percentage in Non-Labor Income	48.5	31.5	55.3	44.5	52.6	-	100	
Economically Active Population (x 1,000)	14	61	454	776	397	215	-	5,247
Value Added in Labor Income (in millions of 1966 pesos)	489	1,855	3,522	2,877	1,785	4,076	4,174	36,079
Value Added in Non-Labor Income (in millions of 1966 pesos)	461	853	4,358	2,306	1,978	-	-	34,297
$\frac{\text{Value Added in Labor Income}}{\text{EAP}}$ (in thousands of 1966 pesos)	34.95	30.41	7.76	3.71	4.50	18.96	-	

*/ Source: see text.

exist in the wage rate per member of the labor force for the various sectors (i.e., the sectoral wage bill divided by the number of EAP in that sector).

The third step was to derive the distribution of labor income based on information regarding the sectoral distribution. Thus, as is shown in Table 6 it is possible to obtain a first approximation of the distribution of labor income for the members of the labor force. This requires ranking sectors (and subsectors) according to the prevailing wage rate and assuming that all workers in any given sector (or subsector) earn the same (i.e., average) wage rate. This last assumption is, of course, unrealistic. In fact, every sector has its own distribution around the mean wage rate and the true income distribution of total labor income can only be exactly derived when all the sectoral distributions are known.*/ Nevertheless, the procedure used in Table 6 provides a rough approximation of the distribution of labor income. It is interesting to notice that the clustering of sectors on the basis of the sectoral wage rate reveals the big gap which exists between the traditional and modern sectors. Personal services, agriculture and craft industry with annual wage rates varying between 3,700 and 4,500 pesos in 1966 clearly belong to the first group, while utilities and finance with wage rates above 30,000 pesos; government services (19,000) and modern manufacturing (15,800) belong to the modern sector. It can be seen from Table 6 that the distribution of wage income tends to be much more equal than that of total income--as one would expect. (It is, of course, likely that the distribution given in Table 6 exaggerates the degree of equality by making the assumption of one unique wage rate by sector.)

The fourth step, after having obtained a rough distribution of labor income, is to derive the distribution of total (labor and non-labor) income. Table 7

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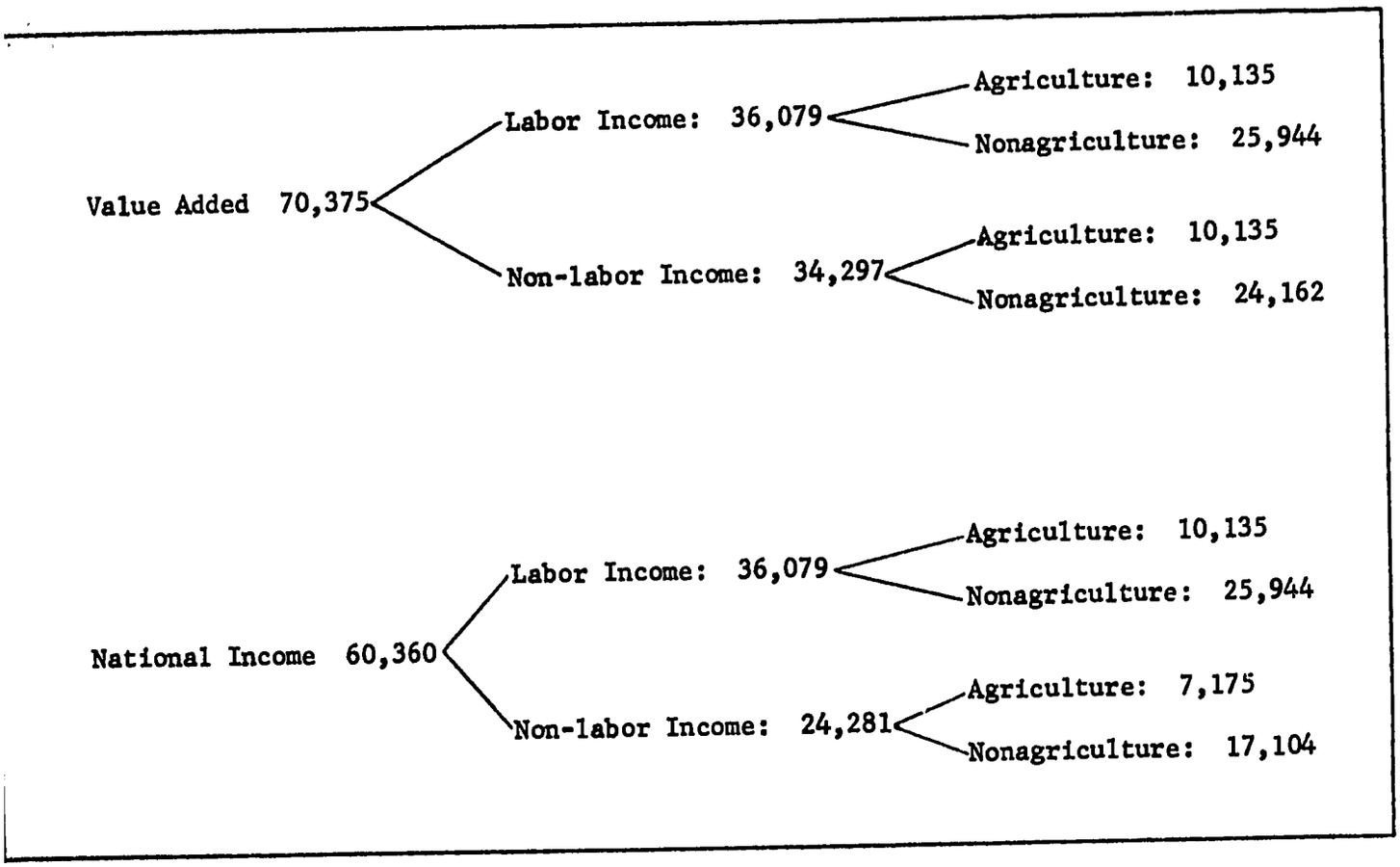
*/ The sensitivity of the overall personal income distribution to the distributional characteristics of sectors is rigorously analyzed in Appendix C. The results of that analysis are summarized in the next subsection.

Table 6. Colombia: Distribution of Labor Income Based on Sectoral Income (1966).

Sector	Wage Rate (Labor Income per Member of EAP) (thousands)	Economically Active Population (EAP) (x 1000)	Total Labor Income (millions)	Cumulative Labor Force (x 1000)	%	Cumulative Income (millions)	%
Personal Services	3.71	776	2,877	2,776		2,877	
Agriculture	4.04	2,507	10,135	3,283		13,012	
Craft Industry	4.50	397	1,785	3,680	70.13	14,797	41.01
Commerce	7.76	454	3,522	4,134	78.78	18,319	50.77
Construction	10.82	239	2,586	4,373		20,905	
Mining	11.22	80	898	4,453		21,803	
Transportation and Communication	15.27	204	3,114	4,657		24,917	
Modern Manufacturing	15.81	300	4,742	4,957	94.47	29,659	82.20
Government Services	18.96	215	4,076	5,172		33,735	
Finance	30.41	61	1,855	5,233		35,590	
Utilities	34.95	14	489	5,247	100.00	36,079	100.00
Total		5,247	36,079				

Source: See text.

Table 7. Colombia: Distribution of Value Added (=GDP at market prices) and National Income between Labor and Non-labor Income and between Agriculture and Non-agriculture, 1966 (in millions of 1966 pesos).



Note: The difference between Value Added (GDP at market price) and National Income consists of indirect taxes and subsidies (-2,243), of capital consumption allowance (-2,716), and net factor income from abroad (-627).

shows the distribution of total value added (=GDP at market prices) and national income between labor and non-labor income with the latter categories further broken down between agriculture and non-agriculture. We are interested in obtaining the distribution of national income. In order to do so, indirect taxes and subsidies, capital consumption allowance and net factor payments to the rest of the world are deducted from non-labor value added.

The new distribution of national income which is given in Table 8 is built on the basis of the following steps and assumptions: (1) agricultural labor and non-labor income (17,310 million pesos) is distributed according to the four income classes given in Table 9; (2) non-agricultural labor income (25,944 million pesos) is distributed according to the sectoral distribution given in Table 6, with the qualification that 5 percent of the wage income of all sectors is allocated to the top 5 percent of the population (in all likelihood this would represent the imputed labor income of the managerial and entrepreneurial class in each sector); (3) all non-agricultural non-labor income (17,104 million pesos) is assumed to be received by the top 5 percent of the population (note, likewise, that the agricultural income accruing to the top 5 percent of the people in agriculture--i.e., Agricultural Class IV in Table 9--is also included in this top-income category); (4) the participation rate is the same for all sectors--i.e., the ratio of members of the EAP to population in each sector is the same.

The resulting income distribution contained in Table 8 is strikingly similar to the actual one computed by Urrutia-Villalba for 1964 and given in Table 4. A comparison of these last two tables shows an extremely good fit between the personal income distribution and that derived from sectoral information. A more formal test of the similarity of these two distributions consists of comparing their respective coefficients of income concentration (the

Table 8. Colombia: Distribution of Income by Sector and Derived Personal Income Distribution, 1966*
(in millions of 1966 pesos and thousands of population).

	Average Income per Person (x 1000)	Sector Income (millions)	Population (x 1000)	Cumulated Income (millions)	Cumulated Population (x 1000)	Percent Cumulated Income	Percent Cumulated Population
Agriculture I	0.78	3,471	4,450	3,471	4,450	5.8	23.9
Personal Services	1.05	2,732	2,613	6,203	7,063	10.3	38.0
Craft Manufacturing	1.27	1,696	1,337	7,899	8,400	13.1	45.2
Agriculture II	1.30	3,471	2,670	11,370	11,070	18.8	59.9
Commerce	2.19	3,345	1,528	14,715	12,598	24.4	67.7
Agriculture III	2.88	3,827	1,330	18,542	13,928	30.7	74.9
Construction	3.05	2,458	805	21,000	14,733	34.8	79.2
Mining	3.17	854	270	21,854	15,003	36.2	80.6
Transportation and Communication	4.31	2,959	687	24,813	15,690	41.1	84.3
Modern Manufacturing	4.46	4,505	1,011	29,318	16,701	48.6	89.8
Government Services	5.35	3,872	724	33,190	17,425	55.0	93.7
Finance	8.58	1,762	205	34,952	17,630	57.9	94.8
Utilities	9.86	465	47	35,417	17,677	58.7	95.0
Top 5% of All Sectors	26.7	24,943	926	60,360	18,603	100.0	100.0

*/ For methodology see text.

Table 9. Colombia: Distribution of Total Agricultural Income, 1966*
(in 1966 pesos)

Income Class	Percent Population	Percent Agricultural Income	Agri. Income in Each Class (millions of pesos)	Agri. Population in Each Class (millions)	Average Agri. Income per Class (thousands of pesos)
I	50	20.05	3,471	4.45	0.78
II	30	20.05	3,471	2.67	1.30
III	15	22.10	3,827	1.33	2.88
IV	5	37.80	6,543	0.45	14.54
TOTAL	100	100.00	17,310	8.89	1.95

*The above distribution is substantially less unequal than the one derived by Berry [1]. Berry's distribution for 1960 showed the above four income classes receiving, respectively, 14%, 20%, 23%, and 43% of total agricultural income. The resulting per capita annual income for the lower class (I) would amount to only 540 pesos which is very close to the value of the subsistence diet.

Lorenz coefficient, L). The latter corresponding to the income distribution arrived at by Urrutia-Villalba [10] for 1964 was L = 0.57, whereas the one computed on the basis of Table 8 amounted to L = 0.55.*/

A detailed technical note was prepared in Appendix C which discusses (a) a method of estimating the parameters of the lognormal distribution fitted to the Colombian data for 1966; and (b) a method of analyzing the sensitivity of the overall measure of income distribution (the Lorenz coefficient) to unequal dispersions within income-groups or income-classes. The main results of this analysis are, first, that the prevailing Colombian income distribution in the middle '60's approximates closely the lognormal distribution; and, secondly, that the sensitivity of the overall personal distribution to a moderate degree of dispersion within and as between sectoral income groups as given in Table 8 is relatively small. Consequently, the assumption of no dispersion within income-groups (i.e., all individuals in a given sector or subsector receiving the same (average) income) which was made in deriving the personal from the sectoral income distribution can be justified on empirical grounds.

It would, thus, appear that the procedure outlined in this section to obtain a mapping from the sectoral to the personal income distribution could be used in the projection part of the consistency model

Part II. Colombia: Output, Employment and Income Distribution Projections to 1980

1. Introduction

This section is devoted to generating consistent projections of output, employment and income distribution to 1980. The first step consists of projecting the major macroeconomic variables with the help of the macroeconomic model

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*/ See Appendix C which contains a detailed technical note on income distribution in Colombia.

presented in section I.2.b. Secondly, the final demand components consistent with the macroeconomic projections (and particularly the resulting growth rate of GDP) are derived at the sectoral level. Thirdly, the ten sector input-output matrix is used to generate sectoral value added corresponding to the projected final demand variables. Fourthly, different methods of obtaining growth rates of labor productivity by sector are presented and used to derive the sectoral employment effects from the value added projections in step 3. The fifth step consists of obtaining the personal income distribution from the sectoral income distribution and undertaking a few selective reestimations of some of the sectoral final demand projections (e.g., consumption) to take into account the changes in income distribution. Finally, the effects on output, employment and income distribution of certain changes in the input-output structure--implying a change in the agricultural production function--are analyzed. An investment feasibility check is also undertaken.

The results of the empirical analysis undertaken in the first five steps above provides an approximation of the likely consequences of a continuation of the present productive structure. As such the analysis may be useful in identifying structural and policy changes more conducive to the attainment of the objectives of the policymaker. The last step indicates some of the consequences of changes in the process of production in one sector, i.e., agriculture.

2. Macroeconomic Projections

The macroeconomic model constructed and presented in section I.2 is used to project the whole macroeconomic system to 1980. The procedure entailed, first, making reasonable alternative assumptions regarding future values of the exogenous variables and obtaining the resulting paths of endogenous variables with the help of the reduced form. Symbolically, this amounts to solving the following system:

(3) $\hat{y} = R\bar{x} + d$

where

$\hat{y}$ is the vector of endogenous variables

R is the reduced form ($=-A^{-1}B$ as obtained in equation (2) and given in Table A.2 of Appendix)

$\bar{x}$ is the vector of projected exogenous variables, and

d is the vector of constant terms ($= A^{-1}c$ as obtained in equation (2))

Given the specification of the model (see Table 2), the set of endogenous variables had to be solved sequentially (i.e., annually) between 1966 (the base year) and 1980 (the projection year). This was necessary to generate the lagged values of GDP which appear as exogenous variables. In this fashion, the future paths of the five endogenous variables could be traced.

A number of alternative sets of exogenous variables (the $\bar{x}$'s) was used--two of which were ultimately selected to provide a likely range for projection purposes. The two alternatives are shown in Table 10. The projections of the public instruments ($\bar{C}g_t$ and $\bar{I}g_t$) were based partially on past trends and government plans. The rate of growth of GDP is highly sensitive to export performance. Therefore, two alternative growth rates of exports (5 and 7 percent, respectively) and two alternative levels of the terms-of-trade (a 10 percent deterioration by 1980 compared to 1966 and the same level as in 1966, respectively) were used. The high export alternative appears very ambitious and significantly more optimistic than government, UNCTAD and IBRD projections. The lower export alternative appears more likely given the world demand for Colombian exports (e.g., the rate of growth of coffee exports is projected to be not much more than 3 percent annually).*/ Finally, Changes in Stocks and Foreign Exchange

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*/ A more detailed breakdown of the projection growth rates assumed for different export commodity groups is given in section II.3.

Table 10. Colombia, Values of Exogenous Variables Selected for Projections, 1966-1980

	Alternative I	Alternative II
Government Consumption ($\bar{C}g_t$)	5.5% growth rate	5.5% growth rate
Government Investment ($\bar{I}g_t$)	8.1% growth rate	8.1% growth rate
Exports ($\bar{E}_t$)	5% annual growth	7% annual growth
Terms-of-Trade ($\bar{T}_t$)	90% of 1966 level	Same as in 1966
Foreign Exchange Reserves ($\bar{R}_{t-1}$)	10% annual growth	10% annual growth
Changes in Stocks ($\bar{S}_t$)	Using equation S = 1637.2954 + 35.4860(t) t = last 2 digits of year	
Lagged GDP ($\bar{Y}_{t-1}$, $\bar{Y}_{t-2}$)	Values generated by model	

Reserves are projected on the basis on linear trend extrapolation.

Since the macroeconomic model is specified at constant 1958 pesos and the Input-Output information is in 1966 pesos, the macro-projections were converted into 1966 prices by using the official price deflators corresponding to each of the macroeconomic variables, to allow comparability. This procedure implies the maintenance of the 1966 relative prices throughout the projection period.

The resulting values of projected endogenous variables (the $\hat{y}_{80}$'s), obtained through equation (3) and corresponding to the two alternative sets of exogenous variables, are shown in Table 11, together with selected exogenous variables. The compound growth rates of these variables between 1960 and 1980 are also given in Table 11. It can be seen that GDP is projected to grow at 5.2 percent, annually, under Alternative I and by 6.1 percent under the second alternative.

3. Final Demand Projections Consistent with Macroeconomic Projections

The sectoral final demand components consistent with and corresponding to the macroeconomic projections undertaken in the previous section (and summarized in Table 11 were computed and are shown in Table 12 (Alternative I) and 13 (Alternative II). The procedure which was followed consisted of projecting the sectoral components of final demand while remaining consistent with the "controlled totals" resulting from the macro-projections. The structure of the base year (1966) input-output table (see Table 2) can be expressed as follows:

4.1 $F_i^* = E_i - Mf_i + I_i^* + (C_i + \Delta S_i)$

4.2 $F_i = F_i^* - Mi_i$

4.3 $\Sigma F_i = Y$

4.4 $\Sigma(C_i + \Delta S_i) = C + \Delta S$

4.5 $\Sigma E_i = E$

Table 11. Colombia, Base Period (1966) and Projected Values of Endogenous Variables and Selected Exogenous Variables, 1980 (in millions of 1966 pesos and cumulative growth rates)*

	1966	1980			
		Alt. I	Growth Rate 1966-80	Alt. II	Growth Rate 1966-80
GDP (Y)	70,375	142,943	5.2	160,179	6.1
Imports (M)	10,588	19,585	4.5	22,136	5.4
Private Consumption (C_p)	53,274	107,611	5.1	120,222	6.0
Government Consumption (C_g)	4,685	9,761	5.5	9,761	5.5
Total Consumption (C)	57,959	117,372	5.2	129,983	5.9
Changes in Stocks (S)	2,611	2,265	-	2,265	-
Total Consumption and Changes in Stocks (C + S)	60,874	119,637	5.0	132,248	5.7
Exports (E)	8,548	17,484	5.0	22,343	7.0
Private Investment (I_p^*)	11,440	23,144	5.2	25,459	5.9
Government Investment (I_g)	2,908	8,542	8.1	8,542	8.1
Total Investment (I^*)	11,796	25,409	5.6	27,724	6.3

*The 1966 values are based on the Input-Output table for 1966 (see Table 2). Total Value Added (=GDP) in the I-O table amounts to 70,375 million pesos in 1966 which is slightly below the figure given in the official national income accounts (i.e., 73,612 million pesos). To maintain comparability over time the values of the variables projected in the model were adjusted, accordingly, by a factor of .954 (since 70,375 : 73,612 = .954).

Table 12.1. Colombia. Projections of Final Demand Components, to 1980 under Alternative I*/ (millions of pesos at 1966 prices).

	Final Demand 1/		Exports	Imports of Final Capital and Consumer Goods		Capital Formation 2/		Consumption and Changes in Stocks
	Alt. I. a	Alt. I. b		Alt. I. a	Alt. I. b	Alt. I. a	Alt. I. b	
	F_i^*		E_i	Mf_i		I_i^*		$C_i + \Delta S_i$
Coffee	1,588	1,588	1,588					
Agriculture	25,227	25,331	2,339			150	254	22,738
Mining	918	918	918					
Manufacturing	51,139	49,773	8,511	-6,609	-6,738	8,860	7,623	40,377
Construction	12,132	13,265				12,132	13,265	
Transportation & Communication	12,081	12,066	1,736	-788	-803			11,133
Utilities	1,431	1,431						1,431
Finance	5,835	5,835						5,835
Services & Commerce	35,557	35,543	2,392	-739	-753	4,267	4,267	29,637
Housing & Rent	8,486	8,486						8,486
TOTAL	154,394	154,236	17,484	-8,136	-8,294	25,409	25,409	119,637

1/ Includes imports of intermediate goods (Mi). $F_i^* = E_i - Mf_i + I_i^* + C_i + \Delta S_i$ $F_i = F_i^* - Mi_i$

2/ Gross investment-net of changes in stocks.

*/ Projection Alternative I yields a growth rate of GDP of 5.2% annually between 1966 and 1980. For underlying assumptions and behavioral hypotheses see Table 12.2 and text.

Table 12.2. Colombia, Assumptions and Behavioral Hypotheses Underlying Sectoral Final Demand Projections under Alternative I in Table 12.2

Sectors	Exports Projected Growth Rate 1966-1980	Imports of Final Capital and Consumer Goods	Capital Formation (Percentage Distribution) Alt. a	Capital Formation (Percentage Distribution) Alt. b	Consumption and Changes in Stocks Projected Growth Rate 1966-1980	Implicit Income Elasticity of Demand
	E_i	Mf_i 1/	I_i^*		$(C_i + \Delta S_i)$	E_i
Coffee	3.0					
Agriculture	9.0		0.6	1.0	2.6	0.5
Mining	2.5					
Manufacturing	5.4		34.9	30.0	5.8	1.12
Construction			47.7	52.2		
Transportation and Communication	5.0				6.2	1.2
Utilities					6.2	1.2
Finance					6.0	1.15
Services & Commerce	5.0		16.8	16.8	5.2	1.0
Housing & Rent					5.2	1.0
TOTAL	5.0		100.0	100.0		

1/ Solved endogenously in projection model (see text and technical note in Appendix D).

Table 13.1 Colombia, Projections of Final Demand Components to 1980 under Alternative II*/ (millions of pesos at 1966 prices).

	Final Demand	Exports	Imports of Final Capital and Consumer Goods	Capital Formation	Consumption and Changes in Stocks
	F_i^*	E_i	Mf_i	I_i^*	$C_i + \Delta S_i$
Coffee	2,079	2,079			
Agriculture	27,137	2,658		461	24,018
Mining	983	983			
Manufacturing	58,605	11,972	-7,463	8,179	45,917
Construction	14,416			14,416	
Transportation and Communication	12,850	1,719	-871		12,002
Utilities	1,625				1,625
Finance	6,486				6,486
Services & Commerce	39,500	2,932	-737	4,668	32,637
Housing and Rent	9,563				9,563
TOTAL	173,245	22,343	-9,070	27,724	132,248

*/ Projection Alternative II yields a growth rate of GDP of 6.1% annually between 1966 and 1980. For underlying assumptions and behavioral hypotheses see Table 13.2 and text.

Table 13.2. Colombia, Assumptions and Behavioral Hypotheses Underlying Sectoral Final Demand Components Projections Under Alternative II in Table 13.1

Sectors	Exports Projected Growth Rate 1966-1980	Imports of Final Capital and Consumer Goods	Capital Formation (Percentage share of total investment)	Consumption and Changes in Stocks Projected Growth Rate 1966-1980	Implicit Income Elasticity of Demand
	E_i	Mf_i 1/	I_i^*	$(C_i + \Delta S_i)$	E_i
Coffee	5.0				
Agriculture	10.0		1.5	3.0	.49
Mining	3.0				
Manufacturing	8.0		29.5	6.8	1.11
Construction			52.0		
Transportation and Communication	5.0			6.8	1.11
Utilities				7.2	1.18
Finance				6.8	1.11
Services & Commerce	6.6		17.0	5.9	.97
Housing & Rent				6.1	1.0
TOTAL	7.0		100.0		

1/ Solved endogenously in projection model (see text and technical note in Appendix D).

4.6 $\Sigma I_i^* = I^*$

4.7 $\Sigma Mf_i = Mf$

4.8 $\Sigma Mi_i = Mi$

4.9 $M = Mf + Mi$, from which it follows that

4.10 $F = Y = C + \Delta S + I^* + E - M$,

where the subscript i refers to sectors 1 to 10; and

F is final demand

F^* is final demand less intermediate imports

Mi is imports of intermediate goods and services

Mf is imports of final goods and services and all other variables are defined as in the macroeconomic model (see Table 2 for list of symbols)

The macroeconomic projections provide us with the "controlled totals": $(C+\Delta S)$; E, I^*, M and Y for 1980. The assumptions and behavioral hypotheses underlying the sectoral projections of the final demand components are given in Tables 12.2 and 13.2, respectively. Essentially sectoral export projections were based on a consensus of UNCTAD [9] ; IBRD ; ILO [3] and official plan [4] figures. The sectoral contributions to final demand investment (I_i^*) were based on two alternative assumptions: (a) the maintenance of each sector's share of total investment in 1980 compared to 1966 (Alternative a); and (b) a change in these shares consistent with the experience of countries at a somewhat higher stage of development than Colombia (i.e., Mexico and Brazil) (Alternative b). Sectoral consumption (and changes in stocks) was projected on the basis of reasonable values of income elasticities of demand derived from Colombian times series information and international cross-sectional data.

It should be noted that the projected sectoral imports of final capital and consumer goods (Mf_i) are determined so as to be consistent with the input-output

projection model. Indeed, as is discussed in the next section,[*/] a method is devised to insure the consistency of the sectoral imports of intermediate goods (Mi_i) with projected sectoral gross output levels, on the one hand, and also to insure that the sum of sectoral imports of intermediate imports (Mi) and of final imports (Mf) be equal to the projected value of total imports in 1980 ($M_{80} = Mi_{80} + Mf_{80}$). An interesting implication of this last procedure is that as the manufacturing sector's value added increases relative to that of agriculture, intermediate imports grow at a faster rate than GDP (since the proportion of intermediate imports to gross output and value added is higher in the former than the latter sector). Conversely, total imports of final capital and consumer goods become relatively less important compared to intermediate imports. These import trends appear to describe realistically the development process.

4. Sectoral Value Added Projections

The preceding section yields the final demand vectors ($F^*_{i_{80}}$) which are to be used to obtain the sectoral gross output ($X_{i_{80}}$) and value added ($V_{i_{80}}$) projections corresponding to the 1966 I-O structure. Symbolically,

5.1 $X_{80} = (I-A)^{-1}F_{80}^*$

5.2 $V_{i_{80}}/X_{i_{80}} = V_{i_{66}}/X_{i_{66}}$

Thus, the sectoral gross output vector for 1980 (X_{80}) is derived by premultiplying the final demand vector (F_{80}^*)--as projected in Tables 12.1 and 13.1--by the $(I-A)^{-1}$ matrix for 1966, which is given in Table B.3. It is, further, assumed that the share of sectoral value added to gross output remains constant over the projection period (see equation 5.2).[**/] Therefore, the resulting

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[*/] See also the technical note in Appendix D.

[**/] At a later stage this assumption will be relaxed--at least with respect to the agricultural sector.

projections can be interpreted as reflecting the likely effects on sectoral output--and in subsequent steps on employment and income distribution--of the continuation of the present productive structure.

Table 14 shows the sectoral growth rates of value added over 1966-80 which are obtained from equations 5.1 and 5.2 above under both projection alternatives. (see first two columns) It can be seen that the growth rates of both agricultural and manufacturing value added are substantially higher under Alternative II (respectively, 4.6 and 7.2 percent, annually, between 1966 and 1980) than under Alternative I (3.8 and 6.1 percent). It should be noted that the projection model described above in equations 5.1 and 5.2 can only yield projections for the value added of the consolidated services and commerce sector. Thus, the breakdown of the latter as between its four subsectors (commerce, personal services, craft industry and government services) was undertaken on the basis of a likely extrapolation of historical trends.

5. Sectoral Employment Projections

It is clear that sectoral employment projections depend not only on the projections of sectoral value added but also on what happens to labor productivity over time in the various sectors. The relationship which exists between the growth rates of value added (r_{v_i}), labor productivity (r_{p_i}) and employment (r_{e_i}) is as follows:

6. $1 + r_{e_i} = 1 + r_{v_i} / 1 + r_{p_i}$ [*/]

Sectoral employment projections are quite sensitive to the growth rates of labor productivity (the r_{p_i}'s) which are selected. Ideally one would want to derive the latter from sectoral production functions. Unfortunately, the

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[*/] As an approximation equation 6 can be expressed as $r_{e_i} = r_{v_i} - r_{p_i}$ if the product of two (small) growth rates ($r_{e_i} r_{p_i}$) is ignored.

Table 14. Colombia, Growth Rates of Sectoral Value Added (r_{v_i}), Labor Productivity (r_{p_i}) and Employment (r_{e_i}), 1966-1980 under Projection Alternatives I*/ and II. (Compound annual growth rate)

Sector	r_{v_i} Value Added Alternative I	r_{v_i} Value Added Alternative II	r_{p_i} Labor Productivity Alternative I	r_{p_i} Labor Productivity Alternative II	r_{e_i} Employment Alternative I	r_{e_i} Employment Alternative II
Coffee / Agriculture	3.8	4.6	2.0	2.3	1.8	2.3
Mining	4.9	5.8	2.5	2.7	2.4	3.1
Manufacturing	6.1	7.2	3.5	3.7	2.6	3.5
Construction	5.6	7.0	2.0	2.5	3.6	4.5
Transportation and Communcation	6.2	6.9	2.7	2.9	3.5	4.0
Utilities	6.1	7.1	5.0	5.2	1.1	1.9
Finance	5.8	6.7	2.5	2.7	3.3	4.0
Housing Rent	5.2	6.1	-	-	-	-
Services and Commerce	5.4	6.2				
of which						
Commerce	5.7	6.9	1.5	2.2	4.2	4.7
Personal Services	4.7	5.7	1.0	1.2	3.7	4.5
Craft Industry	5.0	5.4	1.0	1.5	4.0	3.9
Government Services	6.0	6.2	2.0	2.2	4.0	4.0
All Sectors	5.2	6.1	2.4	2.8	2.8	3.3

*/Alternative I, a (see Table 12.1).

statistical information does not permit the estimation of even relatively simple production functions since neither sectoral values of the capital stock nor annual investment flows are available. Even CES type production functions which require information on sectoral wage rates and returns to capital rather than sectoral capital stocks or investment flows cannot be estimated for Colombia because of the absence of the above data. Given the lack of information available two alternative procedures were used to obtain sectoral growth rates of labor productivity for projection purposes. The first one was to rely on the recent historical experience of Colombia and the other was to try to use a combination of Colombian time series and international cross-sectional information to estimate, as it were, the r_{p_i}'s corresponding to the sectoral growth rates of value added (the r_{v_i}'s) derived in the preceding section. More specifically, this last procedure consisted, first, of estimating statistically the following relations:

$$7.1 \quad \ln V_i/Y = \alpha_i + \beta_i \ln Y/N + \gamma_i \ln I/N$$

$$7.2 \quad \ln E_i/N = \alpha_i + b_i \ln I/Nr$$

In equation 7.1 the sectoral shares of value added to GDP (V_i/Y) are regressed on per capita GDP (Y/N) and per capita gross investment (I/N) for eight sectors on the basis of Colombian annual data spanning the period 1950-67. The coefficients were estimated by least-squares and most of them proved to be statistically significant. (See Table 15)

Equation 7.2 regresses the shares of sectoral employment (E_i/N) on per capita investment (I/N) for the same eight sectors using a sample of 40 developed and developing countries.*/ The statistical results are given in

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*/ The term r in equation 7.2 refers to the purchasing power exchange rate expressed in dollars. Thus, per capita investment for the 40 countries of the sample are expressed in comparable U.S. dollars.

Table 15. Colombia: Share of Sectoral Value Added (V_i/Y) Regressed on Per Capita GDP (Y/N) and Per Capita Gross Investment (I/N)*/

Sector	Dependent Variable	Intercept α_i	ln Y/N β_i	ln I/N γ_i	$\bar{R}^2$	DW
(1) Agriculture	ln V_1/Y	11.3770	-1.0396 (-22.5151)**	-0.0494 (-2.7029)*	0.9684	2.3115
(2) Mining	ln V_2/Y	3.4473	-0.1801 (-1.1434)	-0.1546 (02.0230)*	0.1836	1.4590
(3) Manufacturing	ln V_3/Y	- 4.9219	1.1404 (14.8714)**	-0.1011 (-2.7161)*	0.9287	0.7011
(4) Construction	ln V_4/Y	- 4.1278	0.3580 (1.0225)	0.4596 (2.7642)*	0.2980	0.6813
(5) Transportation & Communication	ln V_5/Y	- 4.3083	0.6919 (6.7153)**	0.2004 (4.0090)**	0.7903	1.5596
(6) Utilities	ln V_6/Y	-24.6660	3.6522 (24.2854)**	-0.4118 (-5.6432)**	0.9725	1.3467
(7) Finance	ln V_7/Y	- 0.3733	0.3064 (3.7202)**	0.1846 (4.6198)**	0.6810	0.5862
(8) Services and Commerce	ln V_8/Y	2.6161	0.1576 (2.3653)*	-0.0835 (-2.5817)*	0.3543	1.4552

*/ The coefficients were estimated by classical least-squares on the basis of annual observations at constant 1958 prices covering the period 1950-1967. One star signifies significance at the 5 percent level and two stars significance at the 1 percent level. The equation which was estimated is $\ln V_i/Y = 1\alpha_i + \beta_i \ln Y/N + \gamma_i \ln I/N$.

Table 16. It can be seen that all Beta's are statistically significant at the one percent level.

Combining equations 7.1 and 7.2, one obtains an expression for sectoral labor productivity as follows:

$$7.3 \quad \ln(V_i/E_i) = (\alpha_i - a_i) + (1 + \beta_i)\ln(Y/N) + \gamma_i \ln(I/N) - b_i \ln(I/Nr)$$

Finally, from equation 7.3, it is possible to derive the sectoral growth rates of labor productivity corresponding to the per capita GDP and investment levels of Colombia during the projection period,

$$7.4 \quad \frac{d\ln(Vi/Ei)}{dt} = (1 + \beta_i)\frac{d\ln(Y/N)}{dt} + \gamma_i \frac{d\ln(I/N)}{dt} - b_i \frac{d\ln(I/N)}{dt}$$

Thus, equation 7.4 provides estimates of r_{p_i}'s derived from pooled Colombian time-series and cross-sectional information. The resulting growth rates of labor productivity are given in column I of Table 17 (under Method I) together with estimates based on the recent historical trends. On the whole, the estimated r_{p_i}'s obtained through equation 7.4 appear reasonable. There are some differences between the latter and those based on the recent past. In particular the estimates for agriculture and manufacturing appear on the low side.

The next step consisted of selecting values of r_{p_i}'s likely to prevail over the projection period and corresponding to the two growth alternatives. It is obvious that an element of arbitrariness enters in the selection process which is unavoidable given the information available and the present state of knowledge. The magnitudes of the r_{p_i}'s used for projection purposes were based on a combination of historical and estimated values (see Table 17) and are given in Table 17. After these growth rates of labor productivity have been postulated, it is possible to derive the growth rates of employment (r_{e_i}) which are consistent with the projections of sectoral value added, Table 17 summarizes the information on the growth rates of sectoral value added, labor productivity and

Table 16. Shares of Sectoral Employment to Population (E_i/N) Regressed on Per Capita Investment (I/N)*/

Sector	Dependent Variable	Intercept a_i	ln I/N b_i	$\bar{R}^2$	DW
(1) Agriculture	ln E_1/N	4.3666	-0.44725 (-5.67)	0.43862	1.8647
(2) Mining	ln E_2/N	-2.4983	0.31168 (2.57)	0.12376	1.7215
(3) Manufacturing	ln E_3/N	-0.53573	0.50220 (10.20)	0.72066	2.1021
(4) Construction	ln E_4/N	-1.5652	0.4149 (7.57)	0.58472	2.2531
(5) Transportation & Communication	ln E_5/N	-1.6599	0.45619 (12.92)	0.80581	1.9709
(6) Utilities	ln E_6/N	-3.7815	0.50262 (8.56)	0.64412	2.4035
(7) Finance	ln E_7/N	-0.36215	0.36664 (10.06)	0.71478	1.8261
(8) Services and Commerce	ln E_8/N	0.39271	0.30745 (9.20)	0.67686	1.5770

*/The coefficients were estimated by least-squares on the basis of a cross-sectional sample of 40 countries (developed and developing) in 1960-63. The "t" ratios are given in parentheses. All b coefficients are significant at the 1% level. The equation which was estimated is $\ln E_i/N = a_i + b_i \ln I/N$

Table 16. Colombia, Rates of Growth of Labor Productivity by Sector (r_{p_i}) According to Three Alternative Procedures

	Method I[1/] I	Historical 1964-1970 (ILO)[2/] II	Historical 1951-1964 (Slighton)[3/] III
Agriculture	0.9	2.0	2.1
Mining	0.5[4/]	2.5	5.6
Manufacturing	2.8	4.5	3.3
Construction	2.65	2.0	2.1
Transportation and Communcation	2.7	3.0	2.7
Utilities	7.0	8.5	7.6
Finance	2.14	2.5	
Services and Commerce	1.34		
of which			
Commerce		1.0	-1.4
Craft Industry		1.6	
Personal Services		1.5	0.9
Other Services		1.8	

1/ Based on pooled cross-sectional time series information. See equations 7.1 - 7.4 and Tables 15 and 16.

2/ See [3, p. 408]

3/ See [, p.]

4/ Not statistically significant

employment which obtain between 1966 and 1980 under the two growth alternatives.*/

The major trend which is revealed by Table 14 is that overall employment would grow--under our projections--at 2.8 percent under Alternative I and by 3.3 percent under Alternative II. Since the rate of population growth is projected at 3.3 percent, the absolute level of unemployment (or underemployment) is bound to increace considerably under the first alternative and remain at about the base period level (1966) under the second one. The shares of the various sectors in total employment are quite similar under the two projections alternatives, but significantly different from those prevailing in 1966. Thus, the share of agriculture (including coffee) in total employment drops from 47.8 in 1966 to slightly above 41 percent in 1980, while the share of the consolidated "services and commerce" sector increases from 35.1 to about 41 percent over the same period. Thus, to a large extent, the projected shift in the structure of employment is from agriculture to services. One plausible hypothesis is that the rural-urban migration responsible for the above shift represents a substitution of urban employment in the traditional service subsector for rural employment in traditional agriculture. Given the very low labor productivity levels prevailing in both of these sectors, the above process could perhaps better be described as a substitution of urban underemployment for rural underemployment.

6. Sectoral and Personal Income Distribution Projections

It is possible to derive the sectoral distribution of value added from the information generated in the previous sections. Tables 18 and 19 provide these two distributions. It should be noted that it is assumed that the share of labor income out of sectoral value added remains constant over the projection

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*/ See also Tables 18 and 19 for absolute values of employment projections by sector.

Table 18. Colombia: Projection of Distribution of Value Added between Labor and Non-Labor Income by Sector and Sectoral Employment, 1980, under Alternative I

	Agriculture	Mining	Manu-facturing	Con-struction	Trans-portation and Communi-cation	Utilities	Finance
Value Added (in millions of 1966 pesos)	34,218	2,866	27,353	6,176	12,037	2,184	5,980
Value Added in Labor Income (in millions of 1966 pesos)	17,109	1,751	10,941	5,571	7,234	1,125	4,096
Value Added in Non-Labor Income (in millions of 1966 pesos)	17,109	1,115	16,412	605	4,803	1,059	1,884
Economically Active Population (x 1,000)	3,207	110	428	390	326	16	95
Labor Income per member of Sectorial EAP (in thousands of 1966 pesos)	5.33	15.92	25.56	14.28	22.19	70.31	43.11
Labor Income Per Capita (in thousands of 1966 pesos)	1.40	4.19	6.72	3.75	5.83	18.48	11.33

(Continued)

Table 18. Colombia: (Continued)

	Commerce	Personal Services	Craft Industry	Govt. Services	Housing Rent	Total
Value Added (in millions of 1966 pesos)	17,139	9,859	7,423	9,215	8,486	142,937
Value Added in Labor Income (in millions of 1966 pesos)	7,659	5,471	3,521	9,215	-	73,693
Value Added in Non-Labor Income (in millions of 1966 pesos)	9,480	4,388	3,902	-	8,486	69,243
Economically Active Population (x 1,000)	808	1,290	687	372		7,729
Labor Income per member of Sectorial EAP (in thousands of 1966 pesos)	9.48	4.24	5.13	24.77	-	
Labor Income Per Capita (in thousands of 1966 pesos)	2.49	1.11	1.35	6.51		

Table 19. Colombia: Projection of Value Added between Labor and Non-Labor Income by Sector and Sectoral Employment, 1980, under Alternative II.

	Agriculture	Mining	Manufacturing	Construction	Transportation and Communication	Utilities
Value Added (in millions of 1966 pesos)	37,862	3,229	31,269	7,339	13,106	2,483
Value Added in Labor Income (in millions of 1966 pesos)	18,931	1,973	12,508	6,620	7,877	1,279
Value Added in Non-Labor Income (in millions of 1966 pesos)	18,931	1,256	18,761	719	5,229	1,204
Economically Active Population (x 1,000)	3,406	121	476	433	346	18
Labor Income per member of Sectoral EAP (in thousands of 1966 pesos)	5.56	16.31	26.28	15.31	22.77	71.00
Labor Income Per Capita (in thousands of 1966 pesos)	1.56	4.58	7.38	4.30	6.39	19.95

(Continued)

Table 19. Colombia: (Continued)

	Finance	Services and Commerce	Commerce	Personal Services	Craft Industry	Government Services	Housing and Rent	Total
Value Added (in millions of 1966 pesos)	6,684	48,634	20,075	11,263	7,834	9,462	9,563	160,169
Value Added in Labor Income (in millions of 1966 pesos)	4,580		8,974	6,251	3,713	9,462	-	82,168
Value Added in Non-Labor Income (in millions of 1966 pesos)	2,104		11,101	5,012	4,121	-	9,563	78,001
Economically Active Population (x 1,000)	104	3,351	864	1,437	678	372	-	8,255
Labor Income per member of Sectoral EAP (in thousands of 1966 pesos)	44.04		10.39	4.35	5.48	25.44	-	9.95
Labor Income Per Capita (in thousands of 1966 pesos)	12.37		2.81	1.22	1.54	7.14		

period*/ and that the participation rate is the same for all sectors--i.e., the ratio of employment by sector to population is equal to that of total employment to total population (in other words, the number of dependent household members per member of the economically active population is the same in each sector). It can be seen that the dual wage structure which prevailed in 1966 is maintained.

In order to derive the personal income distribution from the sectoral distribution of value added, the same hypotheses were made as in the 1966 derivation (see section I.4.b). First, it was assumed that the ratio of national income to value added would remain constant which yielded Tables 20 and 21, which provide a breakdown of national income into labor and non-labor income and further into agriculture and non-agriculture. Finally, the two alternative personal income distributions--given in Tables 22 and 23--are derived by retaining the four initial assumptions (see section I.4.b and more particularly p. 26).

An examination of these two distributions reveals that they are almost identical under the two growth alternatives. At the same time these resulting distributions for 1980 are significantly more uneven than the income distribution which prevailed in the base period (1966) (see Table 8). Indeed, if the Lorenz coefficient (L) is used to measure the degree of inequality in the income distribution, a value of L = .67 is obtained for 1980 under Alternative I (corresponding to Table 22) which compares with a value of L = .55 in 1966. It is true that to some extent the higher inequality which is projected in 1980 results from the selection of a higher minimum threshold per capita annual income assumed to be 800 pesos in 1980 as opposed to 680 pesos in 1966. However, it is clear that the bulk of the increase in the income distribution inequality in 1980 was caused by changes in the composition of final demand

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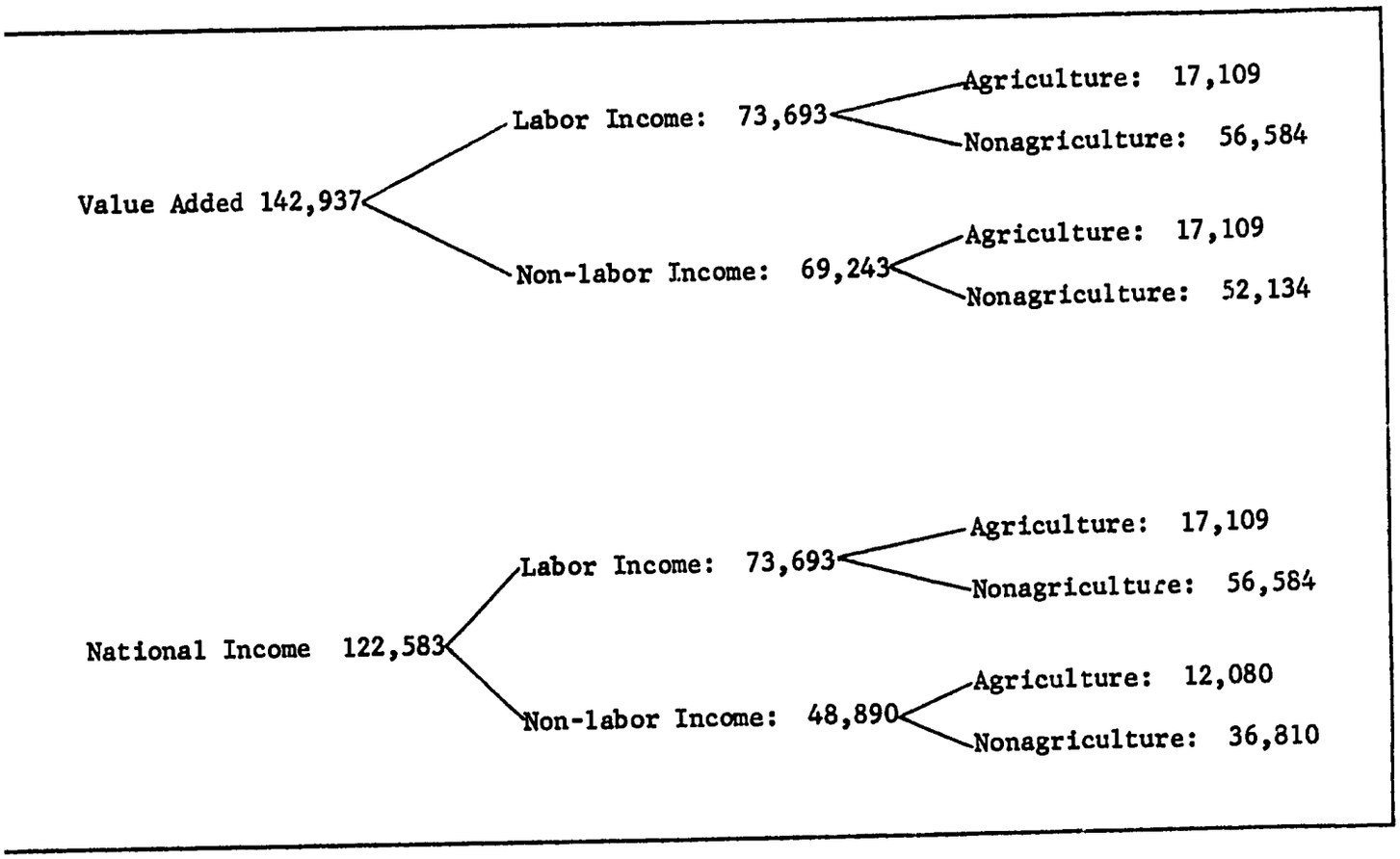
*/ It should be noted that a substantial amount of empirical evidence was gathered in support of the existence of constant returns to scale both in agriculture and in manufacturing (see Appendix E for such evidence). An important implication of constant returns to scale is that the labor and non-labor income shares remain constant.

Table 20. Colombia: Projected Distribution of Value Added (=GDP at market prices) and National Income between Labor and Non-labor Income and between Agriculture and Non-agriculture, 1980 (in millions of 1966 pesos) under Alternative I*/.



*/The ratio of total national income to total value added was assumed to be equal to that prevailing in 1966.

Table 21. Colombia: Projected Distribution of Value Added (=GDP at market prices) and National Income between Labor and Non-Labor Income and between Agriculture and Non-agriculture, 1980 (in millions of 1966 pesos) under Alternative II.*/

Value Added	160,169	Labor Income:	82,168	Agriculture: 18,931
				Nonagriculture: 63,237
		Non-Labor Income:	78,001	Agriculture: 18,931
				Nonagriculture: 59,070
National Income	137,361	Labor Income:	82,168	Agriculture: 18,931
				Nonagriculture: 63,237
		Non-Labor Income:	55,193	Agriculture: 13,396
				Nonagriculture: 41,797

*/ The ratio of total national income to total value added was assumed to be equal to that prevailing in 1966.

Table 22. Colombia: Projected Distribution of Income by Sector and Derived Personal Income Distribution, 1980 under Alternative I*/ (in millions of 1966 pesos and thousands of population).

	Average Income per Person (x 1000)	Income	Population	Cumulated Income	Cumulated Population	Percent Cumulated Income	Percent Cumulated Population
Agriculture I	.96	5,852	6,100	5,852	6,100	4.8	20.7
Personal Services	1.11	5,197	4,662	11,049	10,762	9.0	36.6
Craft Industry	1.35	3,345	2,482	14,394	13,244	11.7	45.0
Agriculture II	1.60	5,852	3,660	20,246	16,909	16.5	57.5
Commerce	2.49	7,276	2,920	27,522	19,824	22.5	67.4
Agriculture III	3.53	6,451	1,830	33,973	21,654	27.7	73.7
Construction	3.75	5,292	1,410	39,265	23,064	32.0	78.4
Mining	4.19	1,663	397	40,928	23,461	33.4	79.8
Transportation and Communication	5.83	6,872	1,178	47,800	24,639	39.0	83.8
Government Services	6.51	8,754	1,344	56.554	25,983	46.1	88.4
Modern Manufacturing	6.72	10,394	1,547	66,948	27,530	54.6	93.6
Finance	11.33	3,891	343	70,839	27,873	57.8	94.8
Utilities	18.48	1,069	58	71,908	27,931	58.7	95.0
Top 5% of All Sectors		50,674	1,470	122,583	29,400	100.0	100.0

*/ See text for methodology.

Table 23. Colombia: Projected Distribution of Income by Sector and Derived Personal Income Distribution, 1980 under Alternative II*/ (in millions of 1966 pesos and thousands of population).

	Average Income per Person (x 1000)	Income	Population	Cumulated Income	Cumulated Population	Percent Cumulated Income	Percent Cumulated Population
Agriculture I	1.07	6,481	6,065	6,481	6,065	4.72	20.63
Personal Services	1.22	5,938	4,862	12,419	10,927	9.04	37.17
Craft Industry	1.54	3,527	2,294	13,946	13,221	11.61	45.31
Agriculture II	1.78	6,481	3,639	22,427	16,860	16.33	57.35
Commerce	2.81	8,525	2,923	30,952	19,783	22.53	67.29
Agriculture III	3.93	7,144	1,820	38,096	21,603	27.73	73.48
Construction	4.30	6,289	1,465	44,385	23,068	32.31	78.46
Mining	4.58	1,874	409	46,259	23,477	33.68	79.85
Transportation and Communication	6.39	7,483	1,170	53,742	24,647	39.12	83.83
Government Services	7.14	8,989	1,259	62,731	25,906	45.67	88.11
Manufacturing	7.38	11,883	1,610	74,614	27,516	54.32	93.59
Finance	12.37	4,351	352	78,965	27,868	57.49	94.79
Utilities	19.95	1,215	61	80,180	27,929	58.37	95.00
Top 5% of All Sectors		57,180	1,470	137,360	29,400	100.00	100.00

*/ See text for methodology.

rather than the selection of a higher truncation point (see Appendix C on income distribution).

It should be recalled at this stage that the income elasticities of demand which were selected for projection purposes were based on the conditions prevailing in Colombia--in the base period including the state of the income distribution. A change in the latter over time is likely to affect at least some of the consumption elasticities. Thus, it is probable that the gradual move towards a more unequal income distribution would have a dampening effect on food demand and a positive effect on manufacturing final consumption demand. In order to test the sensitivity of the output mix to these changes in income distribution a revised final demand vector was used for projection purposes. The only change in the F_{80}^{*} vector used to derive the sectoral gross output and value added vectors consisted in postulating a lower income elasticity of demand for agricultural consumption (ϵ_{ag} = .39 as compared to .5 in the initial projections) and a somewhat higher elasticity of demand for manufacturing goods (ϵ_{ind} = 1.17 instead of 1.12), while maintaining all other assumptions as in the initial projections (see Tables 12 and 13).

The main impact of these changes is to reduce the annual growth rate of agricultural value added from 3.8 to 3.5 percent between 1966 and 1980 while increasing that of manufacturing from 6.1 to 6.4 percent under growth alternative I.*/ Since the employment elasticity with respect to value added is approximately the same in agriculture as in manufacturing**/ the percentage

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*/ Changes of the same general order of magnitude were obtained under Alternative II. It should also be noted that as a result of indirect effects marginal increases obtained in the growth rates of the following sectors: mining, transportation and communication, utilities, and finance.

**/ These employment elasticities can be derived from the figures in Table 14. Thus, under Alternative I the employment elasticities in agriculture and manufacturing come out to be respectively .47 and .43. Under Alternative II the corresponding elasticities are .50 and .49.

decline in agricultural employment growth would be just about equal to the percentage increase in manufacturing employment. In addition, the marginal increases in the growth rates of value added of the sectors indicated in the next to last footnote would lead to small positive employment absorption in these sectors. Since the base-year labor force in agriculture is substantially larger than that in modern manufacturing and other sectors above, the net effect of the revised projections (taking into account the distribution effects) is likely to lead to an overall reduction in total employment--without necessarily worsening the income distribution. (i.e., a larger number of workers would be employed in manufacturing and other high wage sectors than under the initial projections.)

7. Investment Feasibility Check

So far, it has been assumed without any formal check that the output-mix resulting from the alternative projections to 1980 could be produced given the total investment funds generated by the macroeconomic model. At this stage it is important to check whether the available investment funds are sufficient to produce the projected output combinations. In other words, an attempt should be made to calculate the investment requirements to produce the projected sectoral value added combinations and compare the required total investment to the investment availability obtained from the macroeconomic model.

A fairly rudimentary test is all that could be undertaken here given the almost complete scarcity of information regarding sectoral capital stocks and investment flows. The first step consisted in estimating approximately the additional capital required to produce the increase in sectoral value added over the projection period (1966-1980). Table 24 shows in column 4 the incremental value added for the various sectors corresponding to Alternative I. Given the

Table 24. Colombia, Sectoral Value Added and Investment Requirements under Alternative I 1966-1980 (in millions of pesos at 1966 prices).*/

Sector	Value Added 1966	Value Added 1980 Alt. I	Incremental Capital Output Ratio (ICOR)	Incremental Value Added 1966-1980	Incremental Capital (Investment) 1966-1980
Agriculture	20,269	34,218	5.5	13,949	76,720
Alpha	19,455	44,440	4.5	24,985	112,433
Mining	1,469	2,866			
Modern Manufacturing	11,854	27,353			
Utilities	950	2,184			
Transportation and Communication	5,182	12,037			
Beta	19,701	40,597	2.0	20,896	41,792
Construction	2,867	6,176			
Craft Industry	3,763	7,423			
Commerce	7,888	17,139			
Personal Services	5,183	9,859			
Gamma	10,958	23,681	1.0	12,723	12,723
Finance	2,708	5,980			
Government Services	4,076	9,215			
Other Services	4,174	8,486			
Total	70,383	142,936		72,553	243,668

*/ The breakdown into four types of sectors and the ICOR's are based on the ILO study (see Table 1). Alpha group consists of capital-intensive and skill-intensive sectors; beta consists of non-capital, non-skill intensive sectors and gamma includes skill-intensive sectors.

sectoral incremental capital-output ratios (ICOR's) which ILO [7, p. 406] used in its projection model broken down in terms of four major sectors, we can derive the corresponding sectoral incremental capital requirements (see column 5 of Table 24) and the overall capital required over the whole projection period to produce the output-mix resulting under Alternative I. The latter amounted to about 243.7 billion pesos (at 1966 prices) as can be seen in Table 24.

The next step was to generate the annual gross investment path over the projection period from the macroeconomic model. The sum of cumulated gross investment over the projection period amounted to over 263 billion pesos, i.e., $\sum_{t=1966}^{t=1979} I_t = 263.3$ billion pesos.
Thus, it follows that the flow of investment projected to be forthcoming during 1966-1980 is more than sufficient to produce the incremental value added corresponding to the lower growth alternative. A similar test was undertaken for the higher growth alternative (Alternative II) which indicated likewise that investment availability would not constrain the attainment of the output levels corresponding to that alternative.

8. Projections under Technological Change in Agriculture

The set of projections undertaken in the previous sections assumed the maintenance of the productive (input-output) structure of the Colombian economy. As such the results of these projections do reflect the consequences likely to prevail under conditions of no (or minor) structural changes. Their potential usefulness for policy purposes derives from the fact that they offer the policy-maker a view of what could happen if essentially neutral technological policies are adopted.

It is, of course, probable that significant technological changes may occur in Colombia during the projection period which would have the effect of altering

the transaction matrix and affecting the projected sectoral output and employment mixes and the projected income distribution. It is extremely difficult to estimate the new sets of input-output coefficients which might prevail over the course of the projection period. Rather than attempting to guess at the new A matrix, it was assumed that the only sector subjected to technological changes was agriculture. A characteristic of agricultural development is that the share of intermediate inputs in total output increases substantially throughout the developmental process. This share amounted to 15 percent in 1966 (see Table B.2). It was assumed that over the projection period the proportion of all intermediate inputs would increase by respectively 50 and 100 percent. In other words, two new column vectors were postulated for the agricultural sector in the A matrix. In the first alternative all input-output coefficients of the agricultural column vector (representing the linear agricultural production function) were multiplied by one and a half and in the second alternative they were doubled. Thus, the total share of intermediate inputs to gross agricultural output is postulated to rise from 15 percent to, respectively, 22 and 30 percent during the projection period. All other column vectors, representing the other sectors' production functions, were assumed to remain unchanged--as in the 1966 A matrix.

This revised matrix (A^*) was used to project sectoral gross output and value added in 1980 corresponding to the same final demand projections as in section II.3. Thus,

(8.1) $X'_{80} = (I - A^*)^{-1} F_{80}{}^*$, where A^* is the coefficient matrix under technological change in agriculture.

It should be noted that the sectoral projected ratios of value added to gross output ($V'_{i_{80}}/X'_{i_{80}}$) are no longer equal to the base year ratios ($V_{i_{66}}/X_{i_{66}}$). However, it is only in the agricultural sector that this change is

substantial--the ratio rising from 15 to above 30 percent. In Table 25, the growth rates of sectoral value added resulting from the projection without technological change (Alternative A) and with technological change in agriculture (Alternative B) are given.*/ It can be seen that the major impact of the postulated technological changes in agriculture is to reduce significantly the growth rate of agricultural value added under both the "low" and "high" growth alternatives, and to increase slightly the growth rate of manufacturing value added and a few other sectors supplying additional inputs to agriculture. In contrast, the growth rates of agricultural gross output increase slightly under technological change (i.e., Alternative I. B > Alternative I. A and Alternative II. B > Alternative II. A).

The question which suggests itself at this stage is what are the implications of these hypothetical technological changes in agriculture on overall employment and its sectoral distribution and on income distribution? The changes in the composition of value added which are shown in Table 25 are bound to have important implications on employment and income distribution. Before the previous question is answered, it is essential to know the effects on labor productivity which are likely to result from the assumed technological changes. Unfortunately, there is no way in the absence of detailed sectoral production functions of determining endogenously the growth rates of labor productivity for the various sectors.

Even though changes in the growth rates of labor productivity of the various sectors (r_{p_i}) might be occasioned by the technological changes postulated in matrix A^*, it will be assumed here that the same r_{p_i}'s which were used in projection alternatives I. A and II. A hold true (see Table 14). This

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*/Alternative A uses the base year A matrix for projection purposes (see equations 5.1 and 5.2) while Alternative B uses the A^* matrix (see equation 8.1).

Table 25. Colombia, Growth Rates of Sectoral Value Added, 1966-1980, Under Alternatives I and II and Under Two Agricultural Production Functions*/ (compound annual percentage growth rates).

Sector	Alternative I A	Alternative I B	Alternative II A	Alternative II B
Agriculture (including Coffee)	3.8	3.1	4.6	3.8
Mining	4.9	5.1	5.8	6.0
Manufacturing	6.1	6.5	7.2	7.5
Construction	5.6	5.6	7.0	7.0
Transportation and Communication	6.2	6.5	6.9	7.2
Utilities	6.1	6.3	7.1	7.3
Finance	5.8	6.4	6.7	7.2
Housing Rent	5.2	5.2	6.1	6.1
Services and Commerce	5.4	5.6	6.2	6.4

*/ The first agricultural production function (A) corresponds to the initial (1966) input-output coefficients of the agricultural column vector. The second alternative (B) is based on the assumption that all input-output coefficients in the agricultrual column vector are doubled over the projection period. See text for further explanation.

assumption would appear to be fairly realistic--since for all sectors except agriculture the changes in projected value added under technological changes are only slightly different from those without technological changes. With respect to agriculture the growth rate of employment which results for Alternative I. B is only 1.1 percent annually compared to 1.8 percent under Alternative I. A.*/

The sectoral and overall employment levels were projected to 1980 under Alternative I. B. Total employment amounted to 7,579 thousands which compared to 7,729 thousands under Alternative I. A. Thus, total employment is likely to fall under the kind of technological change which was postulated. However, a slightly more equal income distribution is likely to result. The reason for the latter is the increased employment in relatively high labor income sectors (e.g., manufacturing) and the reduction in employment in relatively low labor income sectors (e.g., agriculture). The implications of the type of technological progress in agriculture assumed here, e.g., relative increase in intermediate inputs should be of crucial interest for the policymaker. In the case, under review, it would appear that some trade-off between total employment and a more equal income distribution might exist. It is, of course, clear that much more specific and disaggregated information would be necessary before any meaningful policy recommendations could be suggested.

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*/ Corresponding to a growth rate of labor productivity of 2.0 percent per annum. It is interesting to note that since gross output increased faster under Alternative I. B than under I. A and vice-versa for employment growth, the growth rate of productivity measured in terms of gross output per unit of labor increases very substantially under technological change (Alternative I. B). The latter would amount to 3.1 percent which compares with 2.0 percent under Alternative I. A.

Conclusions

A methodology was designed to project within a consistent and multisectoral framework output, employment and income distribution in Colombia. The incentive for undertaking the present study was the awareness of the large number of arbitrary assumptions underlying most employment and output projections made by national and international agencies and individual researchers. More particularly, it was felt that the major ILO "full employment" strategy for Colombia [3] was based on a limited analytical underpinning. An idealized strategy was devised which was not subjected to any kind of multisectoral consistency check either on the production or demand sides.

The present effort was an attempt at building a more rigorous framework and applying it to Colombia. It is clear that a number of theoretical as well as empirical gaps still remain in this study. The researchers were limited by the data basis which is very incomplete--particularly with respect to the availability of a sectoral distribution of capital stocks and investment flows and other inputs which would have permitted the quantitative specification of sectoral production functions.

The present study provides a number of "building blocs" towards the construction of a general equilibrium consistency model which are summarized below.

The first part of the study concentrated on an examination of the present structure. First, a simple macroeconometric model was specified over the period 1950-1967 which explained accurately the macroeconomic performance of the Colombian economy over the sample period. Next, a consolidated input-output table was derived to capture in a more disaggregated fashion in the production and demand relationships prevailing in the base period (1966). By using a sectoral breakdown of employment corresponding to that of the input-output table, it was possible to derive a sectoral distribution of labor-income. The distribution

revealed clearly the duelistic nature of labor income as between "traditional" and "modern" sectors existing in Colombia. Furthermore, a methodology was designed to derive the personal income distribution from the sectoral income distribution. The mapping from the sectoral to the personal income distribution necessitated the postulation of a number of assumptions regarding, among others, the distribution of non-labor income. It was shown that this derived personal income distribution corresponded very closely with the one obtained from fiscal, sample survey and other sources.

The second part of the study was devoted to the specification of a consistent projection framework. On the basis of likely projections of exogenous variables (mainly exports and terms-of-trade), two growth alternatives were obtained from the macroeconomic model for the whole set of endogenous variables. It was seen that the growth rate of GDP--given the present structure of the economy was unlikely to exceed 6 percent annually over the period 1966-1980. The macroeconomic projections were linked with the input-output model to obtain sectoral projections of the components of final demand, gross output, value added and employment assuming the maintenance of the intersectoral structure existing in the base period.

The derivation of sectoral employment projections is quite sensitive to assumptions regarding the growth rates of labor productivity. A modest attempt was made at reducing the arbitrariness of the results by computing the latter endogenously from pooled Colombia time-series and international cross sectional information.

From other projections and using the method developed in Part I, it was possible to derive the corresponding sectoral and personal income distribution likely to prevail in 1980. The most noteworthy findings were that unemployment

was likely to increase significantly and the income distribution to become more uneven. This last observation led to revised projections of final demand consumption expenditures in line with the projected change in income distribution. A rudimentary investment feasibility check indicated that the projected level of investment from the macroeconomic model would be sufficient to produce the output mix resulting in 1980 under the two growth alternatives. Thus, the first major conclusion at that stage of the study was that the maintenance of the productive and technological structure existing in the base period was likely to alter the sectoral output mix in such a way as to worsen the employment situation and the income distribution. In the final section of the study, an attempt was carried out to follow through the impact of technological change in agriculture on the distribution of employment and income. It was found that within the restrictive hypotheses used, technological change in agriculture might result in a small decline in absolute employment but in a less uneven income distribution than that obtaining without technological change.

It is interesting to compare the results of our study with the "idealized" strategy which ILO formulated for Colombia. Table 26 summarizes in a highly consolidated form--corresponding to ILO's breakdown--the results obtained under out two growth alternatives and under ILO's full employment strategy. It can be seen, at the outset, that ILO postulated a target growth rate of GDP of above 8 percent annually, over the projection period, which is substantially higher than what we would consider possible under our alternatives (which yield a corresponding range of between 5.2 and 6.1 percent). In addition, ILO uses sectoral growth rates of labor productivity quite different from the ones contained in this study. The rate of growth of labor productivity (3.5 percent) appears unreasonably high even under major technological changes, while that of the capital and skill-intensive sectors (e.g., manufacturing) appears low. As a consequence of the high growth hypotheses and the above selection of labor productivity growth rates, the

Table 26. Colombia: Comparisons of Results Obtained in Consistency Study under Alternatives I and II with ILO Full Employment Strategy, 1966-1980 (compound annual growth rates 1966-1980).

Sectors	r_{v_i} Value Added			r_{e_i} Employment			r_{p_i} Labor Productivity		
	Alt. I	Alt. II	ILO	Alt. I	Alt. II	ILO	Alt. I	Alt. II	ILO
Agriculture	3.8	4.6	5.4	1.8	2.2	1.8	2.0	2.4	3.5
Alpha[1/]	6.1	7.0	9.1	2.8	3.4	6.9	3.3	3.6	2.9
Beta[2/]	5.3	6.3	8.5	3.9	4.4	6.9	1.4	1.9	1.5
Gamma[3/]	5.7	6.3	9.3	3.8	4.0	8.3	1.9	2.3	1.0
GDP	5.2	6.1	8.1	2.8	3.3	4.8	2.4	2.8	3.2

1/ Alpha sectors are the capital and skill-intensive sectors: mining, manufacturing, utilities and transportation.

2/ Beta sectors are neither capital nor skill-intensive, i.e., construction, craft industry, commerce and personal services.

3/ Gamma sectors are skill-intensive, i.e., finance, government services and other services.

growth of employment which results is very high (4.8 percent annually) compared to our projections (2.8-3.3 percent annually).

Finally the sectoral growth rates of value added in the ILO alternative do not appear to be internally consistent from the demand side. A growth rate of agricultural value added of 5.4 percent seems very high given likely values of the income elasticity of demand for food in Colombia and the export prospects.

We believe that in a modest way, the framework which has been developed in this study may help in the formulation of internally consistent projections.

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Appendix A: Macroeconometric Model

Table A.1. Macroeconomic Model of Colombia (Two-Stage Least-Squares Estimates of Macro-Model)

1. (OLS) $C_{p_t} = -875.41 + 0.8148Y_{t-1}$ $\quad \bar{R}^2 = 0.9849$
(-1.5541) (32.2785)

2. (TSLS) $M_t = -4863.0 + 0.1877Y_t + 4.067.0\bar{T}_t + 0.7287\bar{R}_{t-1}$ $\quad R^2 = 0.7301$
(-2.792) (5.386) (4.411) (1.568)

3. (TSLS) $I_{p_t}^{*} = 1330.0 + 0.3973(\bar{Y}_{t-1} - \bar{Y}_{t-2}) + 0.3878M_t$ $\quad R^2 = 0.7607$
(3.486) (2.235) (3.987)

4. $Y_t = C_{p_t} + \bar{C}_{g_t} + I_t + \bar{E}_t - M_t$

5. $I_t = I_{p_t}^{*} + \bar{I}_{g_t} + \overline{\Delta S}_t$

Note: Figures in parentheses are $\beta/SD(\beta)$ where β denotes the coefficient and $SD(\beta)$ is the standard deviation. Hence, in OLS equation i.e., (1), figures in parentheses are t values. In two stage least-squares equations, R^2's are based on instruments.

Table A.2. Impact Multipliers of Macroeconomic Model

Endogenous Variables \ Exogenous Variables	C_g Government Consumption	I_g Government Investment	E Exports	T Terms of Trade	R_{-1} Reserves Lagged One Year	Y_{-1} GDP Lagged One Year	Y_{-2} GDP Lagged Two Years	ΔS Changes in Stocks
(Y) Gross Domestic Product GDP	0.9051	0.9051	0.9051	-2113.1514	-0.3314	1.0794	-0.3419	0.9051
(C_p) Private Consumption	0.0	0.0	0.0	0.0	0.0000	0.8148	0.0	0.0
(M) Imports	0.1613	0.1613	0.1613	3590.1309	0.5631	0.1923	-0.0609	0.1613
(I_p^*) Private Investment	0.0664	0.0664	0.0664	1476.9792	0.2316	0.4569	-0.4029	0.0664
(I) Total Investment	0.0664	1.0664	0.0664	1476.9792	0.2316	0.4569	-0.4029	1.0664

Appendix B: Input-Output Information

Table B.1a. Colombia. Breakdown of Final Demand Components in 1966*/ (millions of pesos at 1966 prices).

Sector	F_i^*(1)	E_i	$-Mf_i$	I_i^*	$C_i+\Delta S_i$(2)
(1) Coffee	1,050	1,050(10)			
(2) Agriculture (excluding coffee)	16,310	645		70	15,595
(3) Fish	162	15			147
(4) Forestry	177	40			137
(5) Mining (including petroleum)	650	650(14)			
(6) Food Stuffs	7,889	3,063			4,826
(7) Beverages	2,703		53(12)		2,756
(8) Tobacco	788		2(12)		790
(9) Textiles	2,314	138			2,176
(10) Clothing	1,550	7			1,543
(11) Wood Products (except furniture)	63	7			55
(12) Wood Furniture	98				98
(13) Paper Products	491	99			392
(14) Printing	387				387
(15) Leather Goods	269	3	11(12)		277
(16) Rubber Products	324	60			264
(17) Chemical Products	1,695	410			1,285
(18) Petroleum and Carbon Derivatives	152	137			15
(19) Non-metallic Minerals	252	65	58(12)		245
(20) Basic Metals	328	12	790(12)	130(5)	976
(21) Metal Products (except transport equipment)	672	33	341(12)	266(4)	714
(22) Non-electric Machinery	239	21	1,787(12)	1,786(4)	219
(23) Electric Machinery	713	11	496(12)	874(4)	324
(24) Transport Material	237	2	1,207(12)	1,057(8)	385

(Continued)

(Continued)

Table B.1.- Colombia. Breakdown of Final Demand Components in 1966*/ (millions of pesos at 1966 prices).

Sector	F_i^*(1)	E_i	$-Mf_i$	I_i^*	$C_i+\Delta S_i$(2)
(25) Miscellaneous Products	548	8			540
(26) Construction	5,632			5,632(7)	
(27) Transport	4,585	868	566(12)		4,283
(28) Communications	496				496
(29) Utilities (electricity, water and gas)	614				614
(30) Finance (banking, insurance, etc.)	2,582				2,582
(31) Services and Commerce (personal and professional services, artisan industry and commerce)	17,232	1,204(11)	531(13)	1,981(9)	14,578
(32) Housing and Rent	4,174				4,174
TOTAL	75,376	8,548(3)	5,842(3)	11,796(3)	60,874(3)

*/ See explanatory notes on next page.

Explanatory Notes to Table B.1

(1) From I-O table for Colombia 1966. Sector 32, Housing and rent was added.

(2) Computed as a residual after all other vectors X, M, I were determined.

(3) These figures were arrived at by adjusting National Accounts figures by the discrepancy factor between the I-O table and the National Accounts.

(4) Estimated from Brazilizn I-O table (1959) in van Rickeghem ("The Economy of Brazil", Howard S. Ellis, ed.). Figures were taken as constant proportion of total investment.

(5) Estimated from Mexican I-O table (1960) in "Factor Intensities in Mexico with Special Reference to Manufacturing", Gerard Boon.

(6) Taken from National Accounts. Figure is investment in draft animals.

(7) It was assumed that all construction output was taken as investment.

(8) Taken from National Accounts.

(9) Computed as a residual.

(10) It was assumed that all of the final demand in the coffee sector went into exports, hence, all domestic demand for coffee was through the food processing sector (sector 6).

(11) Computed as a residual.

(12) These are investment and consumption goods sectors, hence, all imports are treated as competitive imports.

(13) Computed as a residual.

(14) It was assumed that all of final demand was exported. This figure is less than export of crude oil. The residual was included in export from sector 17.

Table B.2. Colombia. The A Matrix for 1966.

	Coffee	Agriculture	Mining	Manu-facturing	Construction
(1) Coffee	0.0000	0.0000	0.0000	0.0616	0.0000
(2) Agriculture	0.0000	0.0464	0.0070	0.0772	0.0039
(3) Mining	0.0000	0.0000	0.0000	0.0254	0.0257
(4) Manufacturing	0.0158	0.0520	0.0216	0.2123	0.3542
(5) Construction	0.0000	0.0000	0.0000	0.0000	0.0000
(6) Transportation & Communication	0.0019	0.0124	0.0316	0.0597	0.0165
(7) Utilities	0.0000	0.0003	0.0035	0.0100	0.0098
(8) Finance	0.0089	0.0163	0.0053	0.0186	0.0183
(9) Services & Commerce	0.0006	0.0198	0.0374	0.0533	0.0518
(10) Housing & Rent	0.0000	0.0000	0.0000	0.0000	0.0000

	Transportation & Communication	Utilities	Finance	Services & Commerce	Housing & Rent
(1) Coffee	0.0000	0.0000	0.0000	0.0000	0.0000
(2) Agriculture	0.0008	0.0000	0.0000	0.0000	0.0000
(3) Mining	0.0016	0.0244	0.0000	0.0000	0.0000
(4) Manufacturing	0.2373	0.0552	0.0423	0.0000	0.0000
(5) Construction	0.0000	0.0000	0.0000	0.0000	0.0000
(6) Transportation & Communication	0.0139	0.0197	0.0786	0.0000	0.0000
(7) Utilities	0.0046	0.0827	0.0272	0.0000	0.0000
(8) Finance	0.0114	0.0134	0.0078	0.0000	0.0000
(9) Services & Commerce	0.0625	0.0489	0.1369	0.0000	0.0000
(10) Housing & Rent	0.0000	0.0000	0.0000	0.0000	0.0000

Table B.3. Colombia. The $(I-A)^{-1}$ Matrix for 1966.

	Coffee	Agriculture	Mining	Manu-facturing	Construction	Transportation & Communication	Utilities	Finance	Services & Commerce	Housing & Rent
(1) Coffee	1.0014	0.0047	0.0024	0.0805	0.0291	0.0195	0.0054	0.0051	0.0000	0.0000
(2) Agriculture	0.0018	1.0571	0.0106	0.1064	0.0427	0.0265	0.0074	0.0068	0.0000	0.0000
(3) Mining	0.0006	0.0021	1.0012	0.0338	0.0382	0.0100	0.0290	0.0030	0.0000	0.0000
(4) Manufacturing	0.0220	0.0770	0.0395	1.3071	0.4719	0.3160	0.0877	0.0832	0.0000	0.0000
(5) Construction	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(6) Transportation & Communication	0.0041	0.0196	0.0352	0.0843	0.0498	1.0356	0.0295	0.0865	0.0000	0.0000
(7) Utilities	0.0005	0.0019	0.0046	0.0156	0.0171	0.0093	1.0919	0.0313	0.0000	0.0000
(8) Finance	0.0094	0.0192	0.0067	0.0283	0.0293	0.0186	0.0170	1.0110	0.0000	0.0000
(9) Services & Commerce	0.0034	0.0291	0.0431	0.0830	0.0872	0.0855	0.0634	0.1500	1.0000	0.0000
(10) Housing & Rent	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000

Appendix C. Annex on Income Distribution in Colombia

This note discusses two points: (1) a method of estimating the parameters of the lognormal distribution fitted to Colombian data for 1966 and (2) a method of analyzing the sensitivity of the overall measure of income distribution (e.g., Lorenz coefficient of concentration) to unequal dispersions within income-groups or income-classes.

Denoting income by $x(0 < x < \infty)$, the cumulative distribution of a three-parameter lognormal curve may be written as

$$\Lambda(x \mid \tau, \mu, \sigma^2) = \Lambda(x-\tau \mid \mu, \sigma^2); \; x \geq \tau$$

where μ and σ^2 are the two parameters of the normally distributed variable $y = \log_e(x-\tau)$ with a cumulative distribution $N(\mu, \sigma^2)$. The arithmetic mean (α) and variance (β^2) of the lognormally distributed variate $(x-\tau)$ are then

$$\mu = \log_e \alpha - \frac{\sigma^2}{2} \; ; \; \beta^2 = \alpha^2(\exp(\sigma^2)-1).$$

In order to specify a measure of inequality in the distribution of income in Colombia, a three-parameter lognormal distribution function $\Delta(\tau, \mu, \sigma^2)$ was fitted to the sectoral income distribution estimated for 1966. Here τ is the truncation point and μ, σ^2 are the location and dispersion measures. A value of $\tau = 0.68$ was preassigned as a subsistence level determined by the minimum feasible nutritional standards; given this value of τ, the estimates of μ and σ^2 are obtained from the maximum liklihood equations

$$\hat{\mu} = \sum_{i=1}^{14} y_i f_i = \sum_{i=1}^{14} (\log_e x_i) f_i$$

$$\hat{\sigma}^2 = V_B = \sum_{i=1}^{14} (y_i - \hat{\mu})^2 f_i$$

which are known to be consistent. These estimators $\hat{\mu}$, $\hat{\sigma}^2$ are also minimum variance unbiased[1/] if the sample size N is large. The Lorenz coefficient of concentration of income L is related to the parameters of the lognormal distribution as follows:

$$L = 2N(\frac{\sigma}{\sqrt{2}} \mid (0, 1))-1.$$

It is clear that the higher the dispersion measure $\hat{\sigma}^2$, the higher the value of the Lorenz measure as is expected. The estimates $\hat{\mu}$, $\hat{\sigma}^2$ from the income data of Table 1 turn out to be $\hat{\mu} = 4.3162$, $\hat{\sigma}^2 = V_B = 2.3176$. This implies a Lorenz coefficient L = 0.5538. An estimate of the Lorenz coefficient of income concentration in Colombia for 1964 corresponding to the distribution generated by Urrutia-Villalba [10] was L = 0.57. Our estimate based on 1966 data with fourteen income groups appears very close and the lognormal fit is found to be reasonable and appropriate. (See Table C.1)

It is clear that in the projection period the value of the Lorenz coefficient L may differ from its value 0.5538 estimated for the year 1966. There are three different sources for such variations, e.g., (1) the change in the subsistence level of income measured by the index τ and the arithmetic mean income level (α) for the population as a whole (2) the change in the arithmetic mean income levels of the sectors (income groups) and (3) the change in the dispersion of income within a sector. The sensitivity of the Lorenz measure $L = L(\tau)$ due to the first factor may be analyzed from the relation

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[1/] Aitchison, J. and J.A.C. Brown, The Lognormal Distribution. Cambridge: Cambridge University Press, 1957.

Table C.1. Colombia: Distribution of Income by Sector and Derived Personal Income Distribution, 1966*/ (in millions of 1966 pesos and thousands of population).

	Average Income per Person (x 1000)	Sector Income (millions)	Population (x 1000)	Cumulated Income (millions)	Cumulated Population (x 1000)	Percent Cumulated Income	Percent Cumulated Population
Agriculture I	0.78	3,471	4,450	3,471	4,450	5.8	23.9
Personal Services	1.05	2,732	2,613	6,203	7,063	10.3	38.0
Craft Manufacturing	1.27	1,696	1,337	7,899	8,400	13.1	45.2
Agriculture II	1.30	3,471	2,670	11,370	11,070	18.8	59.9
Commerce	2.19	3,345	1,528	14,715	12,598	24.4	67.7
Agriculture III	2.88	3,827	1,330	18,542	13,928	30.7	74.9
Construction	3.05	2,458	805	21,000	14,733	34.8	79.2
Mining	3.17	854	270	21,854	15,003	36.2	80.6
Transportation and Communication	4.31	2,959	687	24,813	15,690	41.1	84.3
Modern Manufacturing	4.46	4,505	1,011	29,318	16,701	48.6	89.8
Government Services	5.35	3,872	724	33,190	17,425	55.0	93.7
Finance	8.58	1,762	205	34,952	17,630	57.9	94.8
Utilities	9.86	465	47	35,417	17,677	58.7	95.0
Top 5% of All Sectors	26.7	24,943	926	60,360	18,603	100.0	100.0

*/This table C.1 is the same table as Table 8 in the text.

$$L(\tau) = \left(\frac{\alpha}{\tau+\alpha}\right) L(0); \ \tau \geq 0$$

i.e., $\partial L(\tau)/\partial\tau$ is negative implying that $L(\tau)$ decreases (increases) as τ increases (decreases). (Also, the impact of changes in the overall per capita income is considered in the macroeconomic model used for projection.)

For analyzing the sensitivity of the overall income distribution to unequal dispersions within specific income groups, two methods are followed. One is based on the analysis of variance between and within groups; the second on the fitting of lognormal distributions within groups.

Assume the entire population N divided into m subpopulation groups $N_1,\ldots,N_m$ for m income groups or classes say. Then the average income $\bar{y}$ for the overall population is given by

$$\bar{y} = \sum_{i=1}^{m} \hat{y}_i f_i; \ \sum_{i=1}^{m} f_i = 1, \ f_i \geq 0$$

where $f_i = N_i/N$ denotes the proportion of subpopulation N_i to total population N and $\hat{y}_i$ denotes the average income per person for income-group $i=1,\ldots,m$. Now if the y_{ij} values have non-zero dispersions around the group average $\hat{y}_i$, then the overall variance (V) can be expressed as the sum of two components, V_w (i.e., variance contribution due to dispersion within groups) and V_B (i.e., variance contribution due to dispersion between groups) assuming independence between the two groups, i.e.,

$$V = V_w + V_B = \sum_{i=1}^{m} \sigma_i^2 f_i + \sum_{i=1}^{m} f_i(\hat{y}_i-\bar{y})^2$$

where σ_i^2 is the variance of y_{ij} around the mean $\hat{y}_i$ of income-group i. If the dispersion within groups measured by σ_i is zero or negligibly small, then V_w will be small compared to V_B so that the total variance V would be very close to V_B. It is clear therefore that a sensitivity analysis should show how V would increase when σ_i^2 is not negligible. This is indicated in Table C.2 by the index

$$S = (V/V_B)-1.$$

Table C.2. Measures of Variance Contribution Within Groups for the Derived Personal Income Distribution in Colombia, 1966.

Sector	x_i av. income (100 m. pesos)	y_i (τ=68)	f_i cumulated population %	Coefficient of Variation (assumed) 2% σ_i^2(I)	5% σ_i^2(II)	(2,5,10%) σ_i^2(III)	(5,1,6,10%) σ_i^2(IV)
Agriculture I	78	2.30259	0.239	$0.0004y_1^2$	$0.0025y_1^2$	$0.0004y_1^2$	$0.0025y_1^2$
Personal Services	105	3.61092	0.141	$0.0004y_2^2$	$0.0025y_2^2$	$0.0004y_2^2$	$0.0025y_2^2$
Craft Manufacturing	127	4.07754	0.072	$0.0004y_3^2$	$0.0025y_3^2$	$0.0004y_3^2$	$0.0025y_3^2$
Agriculture II	130	4.12713	0.147	$0.0004y_4^2$	$0.0025y_4^2$	$0.0004y_4^2$	$0.0025y_4^2$
Commerce	219	5.01728	0.078	$0.0004y_5^2$	$0.0025y_5^2$	$0.0025y_5^2$	$0.0001y_5^2$
Agriculture III	288	5.39363	0.072	$0.0004y_6^2$	$0.0025y_6^2$	$0.0025y_6^2$	$0.0001y_6^2$
Construction	305	5.46806	0.043	$0.0004y_7^2$	$0.0025y_7^2$	$0.0025y_7^2$	$0.0001y_7^2$
Mining	317	5.51745	0.014	$0.0004y_8^2$	$0.0025y_8^2$	$0.0025y_8^2$	$0.0001y_8^2$
Transportation and Communication	431	5.89440	0.037	$0.0004y_9^2$	$0.0025y_9^2$	$0.0025y_9^2$	$0.0036y_9^2$
Modern Manufacturing	446	5.93489	0.055	$0.0004y_{10}^2$	$0.0025y_{10}^2$	$0.0025y_{10}^2$	$0.0036y_{10}^2$
Government Services	535	6.14633	0.039	$0.0004y_{11}^2$	$0.0025y_{11}^2$	$0.0025y_{11}^2$	$0.0036y_{11}^2$
Finance	858	6.67203	0.011	$0.0004y_{12}^2$	$0.0025y_{12}^2$	$0.0025y_{12}^2$	$0.0036y_{12}^2$
Utilities	986	6.82220	0.002	$0.0004y_{13}^2$	$0.0025y_{13}^2$	$0.0025y_{13}^2$	$0.0100y_{13}^2$
Top 5% of All Sectors	2,670	7.86404	0.050	$0.0004y_{14}^2$	$0.0025y_{14}^2$	$0.0100y_{14}^2$	$0.0100y_{14}^2$

Table C.2 Continued.

$\Sigma f_i \sigma_i^2(I) = V_1 = 0.008371$ $\quad$ $S = 0.003612$

$\Sigma f_i \sigma_i^2(II) = V_2 = 0.052369$ $\quad$ $S = 0.022596$

$\Sigma f_i \sigma_i^2(III) = V_3 = 0.061259$ $\quad$ $S = 0.026432$

$\Sigma f_i \sigma_i^2(IV) = V_4 = 0.068106$ $\quad$ $S = 0.029386$

Here no specific distribution assumption is made about the nature of dispersion within groups; instead it is assumed that a given coefficient of variation (v) is preassigned for all groups and then its effects are analyzed under four sets of values. For instance, if $\hat{y}_i$ is the mean for group i, then v = 10% would imply $\sigma_i^2 = 0.01\hat{y}_i^2$ and therefore

$$S = 0.01\ (1 + \frac{\bar{y}^2}{\text{var } \hat{y}}),\ \text{var } \hat{y} = \sum_i (\hat{y}_i - \bar{y})^2 f_i.$$

It appears that the index S varies from 0.36 to 2.9 percent, which would imply a range of variation of the Lorenz coefficient from 0.03 to 0.15.

As a second method we have to estimate the parameters of a specific distribution for analyzing dispersions within each income group. For this purpose the total distribution was divided into four groups:

Income Group	Average Income per person (x 1000) (thousand pesos, 1966)	Percent population
I	0.68 - 2.00	59.9
II	1.70 - 4.50	20.7
III	3.50 - 15.00	14.4
IV	15.00 - 60.00	5.0

For the first three groups lognormal distributions were fitted by the method of ligarithmic probability graph based on quantiles, whereby the estimate of the parameters $\hat{\sigma}$ within the group is obtained as

$$\hat{\sigma} = \log_e \left\{\tfrac{1}{2}\left(\frac{x_{50\%}}{x_{16\%}} + \frac{x_{84\%}}{x_{50\%}}\right)\right\}$$

For the last group (group IV) we did not have any detailed income-specific breakdown of income-classes, so an assumption of 10% coefficient of variation was made. Using these estimates of variances within the four groups and the

formula $V_w = \sum_{i=1}^{4} f_i \sigma_i^2$ we obtain an estimate $V_w = 0.0629$. This implies that the index S is of the order of 2.7 per cent implying a Lorenz ratio of 0.14. The details of the estimates of variances within the first three groups are summarized in Table C.3. It appears that this result has the same order of plausibility as the earlier one where a specific coefficient of variation was preassigned. We should note however that in the lognormal case the income-groups are not mutually exclusive, hence the assumption of statistical independence of values within and between groups may not hold. It seems plausible that as the variances within groups increase, this would impart--relatively speaking--a tendency for the variance between groups to decrease (i.e., this implies that the coefficient of correlation r in the formula $V = V_w + V_B + 2r(V_w V_B)^{\frac{1}{2}}$ is likely to be negative). So long as this holds the Lorenz coefficient is likely to vary within the range 0.55 ± 0.106.

Next we have computed the projected distribution of sectoral incomes and the resulting personal income distribution in 1980 in Table C.4, by using the macroeconomic model and the input-output framework and certain reasonable assumptions about the growth of sectoral labor productivities (see sections II.2-6). Since the average income based on the projected year 1980 was higher than in the base year 1966, the truncation point τ in the three parameter lognormal distribution $\Lambda(\tau, \mu, \sigma)$ was assumed to have a value 0.80, higher than in the base year. The estimate of σ and the Lorenz coefficient L turn out to be $\hat{\sigma} = 1.42$ and $\hat{L} = 0.67$ for the projected year 1980. It is clear that although the truncation point was higher than in the base year, the inequality of personal income distribution as measured by the Lorenz coefficient increased; in other words, the inequality-reducing effect of the improved minimum per capita income (i.e., truncation point) was small compared to the adverse effects of final demand composition obtaining in the projection period 1980. (The L

Table C.3. Estimates of Variance Within Groups under Lognormal Distribution (based partly on data of Table C.2).

Income group		σ_i^2 (estimated)	Population percent
	0.78	0.0726	0.239
	1.05	0.0726	0.141
I	1.27	0.0726	0.072
	1.30	0.0726	0.147
	2.19	0.0557	0.078
	2.88	0.0557	0.072
II	3.05	0.0557	0.043
	3.17	0.0557	0.014
	4.31	0.0310	0.037
	4.46	0.0310	0.055
III	5.35	0.0310	0.039
	8.58	0.0310	0.011
	9.86	0.0310	0.002
IV	26.7	0.2670	0.050

Table C.4. Colombia: Projected Distribution of Income by Sector and Derived Personal Income Distribution, 1980 under Alternative I*/ (in millions of 1966 pesos and thousands of population).

	Average Income per Person (x 1000)	Income	Population	Cumulated Income	Cumulated Population	Percent Cumulated Income	Percent Cumulated Population
Agriculture I	.96	5,852	6,100	5,852	6,100	4.8	20.7
Personal Services	1.11	5,197	4,662	11,049	10,762	9.0	36.6
Craft Industry	1.35	3,345	2,482	14,394	13,244	11.7	45.0
Agriculture II	1.60	5,852	3,660	20,246	16,909	16.5	57.5
Commerce	2.49	7,276	2,920	27,522	19,824	22.5	67.4
Agriculture III	3.53	6,451	1,830	33,973	21,654	27.7	73.7
Construction	3.75	5,292	1,410	39,265	23,064	32.0	78.4
Mining	4.19	1,663	397	40,928	23,461	33.4	79.8
Transportation and Communication	5.83	6,872	1,178	47,800	24,639	39.0	83.8
Government Services	6.51	8,754	1,344	56.554	25,983	46.1	88.4
Modern Manufacturing	6.72	10,394	1,547	66,948	27,530	54.6	93.6
Finance	11.33	3,891	343	70,839	27,873	57.8	94.8
Utilities	18.48	1,069	58	71,908	27,931	58.7	95.0
Top 5% of All Sectors		50,674	1,470	122,583	29,400	100.0	100.0

*/ This table (C.4) is the same table as Table 22 in the text.

coefficient which obtains for 1980 by using the same truncation point as in 1966, i.e., $\tau = .68$ is $L = .64$)

Note however that the computed Lorenz coefficient for the projection year 1980 was approximately within the confidence interval 0.55 + 0.106, which was derived on the basis of 1966 table, assuming that income distributions within groups vary in the same manner. This suggests perhaps that the impact of the increased inequality of income distribution could be analyzed through marginal changes in the income elasticities of demand for consumption goods and services, since the latter assume a fixed distribution of income. Indeed there is some econometric evidence for Colombia showing the role of the distributional inequality in affecting consumption demand per capita. Regressing per capita consumption (C/N) on per capita disposable income (Yd/N) and on the share of non-wage income to wage income (P/W) over the period 1950-1965, one obtains the following relation:

$$1.\quad C/N = 354.16 + \underset{(10.60)}{0.724(Yd/N)} - \underset{(-2.62)}{130.666(P/W)}$$

$\bar{R}^2 = .96$

d.w = 1.39

t ratios given in parentheses

Appendix D. Technical Note on Reconciliation of Total Imports with Intermediate and Final Consumer and Capital Goods Imports within an Input-Output Projection Framework.

The problem is to reconcile the total value of imports (M) obtained from the macroeconomic model with values of intermediate imports and final imports resulting from Input-Output Projections. We have the following relationships:

1. $\vec{F} = \vec{E} + \vec{C} + \vec{\Delta S} + \vec{I} - \vec{M}_f$

2. $\vec{X} = (I - A)^{-1}\vec{F}$

Total final demand for imports is assumed to be distributed proportionately between the sectors as in the base year:

3. $\vec{M}_f = \vec{p}m_f$

where m_f if the total final demand for imports (a scalar) and $\vec{p}$ a vector of proportions.

Total final demand for intermediate imports is

4. $m_f = \sum_{i=1}^{10} m_i X_i$

Therefore,

5. $\sum_{i=1}^{10} m_i X_i + m_f = M$

where M is the controlled total of imports obtained from the macro model.

Denoting $m^1 = (m_1, m_2, m_3, m_4, m_5, m_6, m_7, m_8, m_9, m_{10})$ in equation (5) becomes

6. $m^1\vec{X} + m_f = M$, and

7. $m^1(I - A)^{-1}[\vec{E} + \vec{C} + \vec{\Delta S} - \vec{I} - \vec{M}_f] + m_f = M$

from which m_f can be solved as follows:

8. $$m_f = \frac{M - m^1(I - A)^{-1}[\vec{E} + \vec{C} + \vec{\Delta S} + \vec{I}]}{-m^1(I - A)^{-1}\vec{p} + 1}$$

Appendix E. Note on the Logical Framework of Projection Used in the Study

1. The objective of this note is to offer some clarifying comments on the logical framework of projection used in our approach. The two basic ingredients of the logical framework of our projection are: (1) a method of combining the macroeconomic model with an aggregative version (i.e., containing 9 to 10 sectors) of the input-output model and (2) a procedure for incorporating changes in labor productivity by sectors. The first step essentially estimates the output vector required to sustain a projected level of the final demand vector; this indicates the input requirements consistent with the output vector, provided we have some form of sectoral production functions. The second step above allows for the effect of the labor-augmenting variety of technological progress in estimating the equilibrium requirements of labor for the projection year (1980).

2. Ideally if sectoral production functions were available one could check whether capital requirements consistent with the projected final demand vector could be realized in real terms; in case the realization was not ensured, changes in relative prices and/or policy instruments would have to be incorporated. Also, with regard to the second step one could have checked, under ideal conditions, the plausibility of other forms of technological progress besides the labor-augmenting variety. Since sectoral capital stock data for Colombia are not available, it was not possible to perform the detailed consistency check suitable for ideal conditions. The choice of the labor-augmenting variety of technological progress for estimating equilibrium labor requirements in the projection year 1980 was guided by three basic considerations: (1) it is known from the current theories of growth[1/] that the labor-

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[1/] Burmeister, E. and A. R. Dobell (1970). Mathematical Theories of Economic Growth, London: Macmillan Company.
Morishima, M. (1969). Theory of Economic Growth. Oxford: Clarendon Press.

augmenting variety of technological progress is consistent with a steady-state or equilibrium growth pattern, provided the production function has constant returns to scale with respect to capital (K) and augmented labor ($\bar{L} = Le^{mt}$), and (2) the econometric estimates we made on the basis of international cross-section data for the subsectors of the manufacturing sector could not reject the hypothesis of constant returns to scale, and this was true even when separate regression equations were run for developed and developing countries; (also for the agricultural sector as a whole, the econometric estimates by Hayami and others[2/] on the basis of international cross-section data show that the hypothesis of constant returns to scale cannot be rejected for that sector), and lastly, (3) the incremental capital-output ratios for four major sectors, which were used by the ILO study [7, p. 406] in its projection model were used by us but with a different purpose; i.e., to perform an investment feasibility check (see pages 57-59). The implied assumptions behind using ILO estimates of ICOR were two-fold. First, those estimates incorporated the skill-intensity aspects of labor productivity and in that sense the labor-augmenting technical change may be appropriately incorporated. Second, the constancy of the ICOR in the projection year implies a tendency for the relative shares of capital and labor to remain constant, at the appropriate equilibrium rental rate for capital.

3. It is clear, therefore, that sectoral production functions of the following type

$$(1)\ V_i = F^i(K_i, \bar{L}_i),\ i = 1, 2, 3, 4, 5, 6, 7, 8, 9,$$

(where F^i is homogenous of degree one in K_i and $\bar{L}_i = L\exp(m_i t)$ where m_i is the proportional rate of labor-augmenting technical progress) are assumed to hold in

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[2/] Hayami, Y. (1970). "Industrialization and agricultural productivity: an international comparative study". Journal of Developing Economies.

equilibrium around the year (1980) of projection. From this function it follows that the ratio of V_i to $\bar{L}_i$ is constant whenever the ratio $K_i/\bar{L}_i$ is fixed. In our projection we attempted to estimate the sectoral m_i and allow for its impact in the projection of sectoral employment, by assuming that sectoral requirements of additional capital are feasible. However, when we did the investment feasibility check, we argued that the equilibrium ICOR values given from the ILO study are valid (since it allows for unequal skill intensity of sectors) and this gave us constant capital-output ratios ($K_i/V_i = \beta_i$), at which there must exist by the production function (i) an appropriate capital labor ratio when labor is measured in efficiency units of $\bar{L}_i$. The investment feasibility check makes sure that total additional capital requirements do not exceed the total investment projected from the macroeconomic model. Denoting the latter by K^M and the former by $K^R = \Sigma(1/\beta_i)\Delta K_i$ we have

$$(2) \quad \Delta K^R \leq \Delta K^M$$

Note, however, that this does not imply that $\Delta K_i^R \leq \Delta K_i^M$ for each sector i. It is clear, therefore, that our investment feasibility check by inequality (2) assumes either the sectoral feasibility of additional capital requirements (i.e., $\Delta K_i^R \leq \Delta K_i^M$) or appropriate changes in policy parameters affecting sectoral allocation of aggregate investment. Since the relative prices are given in the I-O model and all our computations are based on a constant set of relative prices, changes in relative prices induced by the violation of sectoral feasibility requirements for capital cannot be introduced. However, a limited amount of sensitivity analysis could still be done in the above framework and this is done in our case in two ways: (1) by introducing changes in personal income distribution which may affect the income elasticities of demand, although the sectoral share of labor income tends to be a constant around the projection year and (2) by considering changes in agricultural inputs in the form of

increased fertilizer and other biological and machanical inputs coming from other sectors.

4. The econometric estimates of the CES type production function for the subsectors of the manufacturing sector, made on the basis of competitive labor market assumptions are presented in Tables E.1 through E.4. These estimates are selective in the sense that we attempted a larger number of alternative specifications, particularly to incorporate the effect of independent variables such as capital labor ratios indicating the intensity of technical progress, some indicators of industrialization as were used by Hayami and some proxy estimates for sectoral capital. However, the introduction of these additional independent variables did not always lead to better results and judging by the consistency and sign-stability of the coefficients the above selective estimates (Tables E.1 through E.4) are probably the best. These estimates show very clearly that the hypothesis of constant returns to scale as subsumed in the CES specification here cannot be rejected at the 5% level of statistical significance. A similar result for agriculture as a whole has been derived by Hayami and Ruttan, who include the role of skills in the form of school education and other characteristics.

Table E.1. Colombia: Selected estimates of the CES production function for subsectors of manufacturing sector (Sample Used: Developed and less developed countries (Equation : $\ln(V_i/L_i = a + b\ln(W_i/L_i)$ [*/])

Subsectors	a	b	t ratio	$\bar{R}^2$
Food	0.995	0.9141	28.6425**	0.9523
Beverage	1.3729	0.9075	24.0245**	0.9336
Tobacco	1.6466	0.8722	15.5909**	0.8552
Textiles	0.7400	0.9134	31.7868**	0.9610
Clothing and Footwear	0.6509	0.9240	33.2646**	0.9642
Wood and Cork Products	0.6577	0.9111	53.7951**	0.9860
Furniture and Fixtures	0.6072	0.9374	48.0060**	0.9825
Paper and Paper Products	0.9576	0.9276	44.6683**	0.9798
Printing and Publishing	0.6327	0.9592	37.2921**	0.9713
Leather and Leather Products	0.6851	0.9130	35.5742**	0.9686
Rubber Products	0.8327	0.9244	30.1332**	0.9568
Chemical and Chemical Products	1.1275	0.9382	49.2285**	0.9834
Petroleum and Coal Products	1.4738	0.9067	13.7450**	0.8209
Nonmetallic Minerals	0.7975	0.9388	51.2455**	0.9846
Basic Metals	0.8729	0.9263	34.1116**	0.9659
Metal Products	0.6774	0.9511	58.0827**	0.9880
Manufacturing of Machinery (excluding electrical machinery	0.6715	0.9501	41.8068**	0.9771
Electrical Machinery	0.8013	0.9138	32.4307**	0.9624
Transport Equipment	0.4683	0.9647	24.0429**	0.9338
Other Manufacturing	0.7332	0.9503	49.4946**	0.9835

*/ The sample consisted of 40 countries for which data for V_i (value added in subsector i), L_i (salaried workers in subsector i) and W_i (wages in subsector i) were available for the different manufacturing subsectors in U.N. "The Growth of World Industries". The sample was broken down into 2 subsamples of developed (21 countries) and developing (19 countries) countries. The criterion used was the per capita income with $600 U.S. as the dividing line. The exchange rates used were the "equilibrium" rates available in U.N. "Yearbook of National Accounts Statistics".

**Indicates significant at 0.005 level.
*Indicates significant at 0.05 level.

Table E.2. Colombia: Selected estimates of the CES production function for subsectors of manufacturing sector (Sample Used: Developed and developing countries (Equation : $\ln(V_i/L_i) = a + b \ln(W_i/L_i) + CM$ where M = 1 for developed countries and M = 0 for developing countries)*/

	a	b	t ratio	c	t ratio	$\bar{R}^2$
Food	1.3576	1.0131	36.9823**	-0.6197	-6.3880*	0.9761
Beverage	1.6120	0.9708	24.5941**	-0.4429	-3.1820*	0.9459
Tobacco	1.9002	0.9481	14.9090**	-0.4474	-2.2003*	0.8679
Textiles	0.9936	0.9771	36.2729**	-0.4394	-4.6934*	0.9744
Clothing and Footwear	0.9045	0.9836	38.7730**	-0.4319	-4.8577*	0.9771
Wood and Cork Products	0.8390	0.9597	59.2610**	-0.3071	-5.1797*	0.9915
Furniture and Fixtures	0.7942	0.9868	52.8826**	-0.3251	-4.8353*	0.9888
Paper and Paper Products	1.1263	0.9741	48.4767**	-0.3103	-4.4387*	0.9863
Printing and Publishing	0.6857	0.9738	32.8986**	-0.0999	-0.9970	0.9713
Leather and Leather Products	0.9872	0.9835	43.3380**	-0.4555	-5.7603*	0.9826
Rubber Products	1.0549	0.9850	31.7298**	-0.4072	-3.7761*	0.9675
Chemical and Chemical Products	1.3069	0.9881	59.6094**	-0.3353	-5.7851*	0.9908
Petroleum and Coal Products	1.8304	1.0047	15.4507**	-0.7245	-3.4479*	0.8592
Nonmetallic Minerals	0.9976	0.9945	63.9504**	-0.3574	-6.4330*	0.9923
Basic Metals	1.0854	0.9886	37.4300**	-0.4029	-4.4507*	0.9768
Metal Products	0.8556	0.9986	72.3635**	-0.3197	-6.3696*	0.9940
Manufacturing of Machinery (excluding electrical machinery)	0.8798	1.0055	46.2793**	-0.3803	-4.7438*	0.9851
Electrical Machinery	1.0714	0.9854	40.6420**	-0.4970	-5.8145*	0.9794
Transport Equipment	0.6550	1.0173	22.6041**	-0.3473	-2.2245*	0.9396
Other Manufacturing	0.9212	0.9987	56.3360**	-0.3317	-5.1384*	0.9899

*/ The sample consisted of 40 countries for which data for V_i (value added in subsector i), L_i (salaried workers in subsector i) and W_i (wages in subsector i) were available for the different manufacturing subsectors in U.N. "The Growth of World Industries". The sample was broken down into two subsamples of developed (21 countries) and developing (19 countries) countries. The criterion used was the per capita income with $600 U.S. as the dividing line. The exchange rates used were the "equilibrium" rates available in U.N. "Yearbook of National Accounts Statistics".

Table E.3. Colombia: Selected estimates of the CES production function for subsectors of manufacturing sector (Sample Used: Developed countries)
(Equation : $\ln(V_i/L_i) = a + b\ln(W_i/L_i)$ [*/]

Subsectors	a	b	t ratio	$\bar{R}^2$
Food	0.6870	1.0959	12.4610**	0.8802
Beverage	1.2337	0.8830	5.0180**	0.5351
Tobacco	1.3277	1.1665	4.4871**	0.4767
Textiles	0.5246	1.0405	29.8771**	0.9770
Clothing and Footwear	0.4333	1.0966	38.8494**	0.9863
Wood and Cork Products	0.5235	0.9739	28.0291**	0.9739
Furniture and Fixtures	0.3904	1.1182	42.8703**	0.9887
Paper and Paper Products	0.8798	0.8870	15.2596**	0.9169
Printing and Publishing	0.5622	1.0052	32.4197**	0.9803
Leather and Leather Products	0.4632	1.0342	32.5383**	0.9805
Rubber Products	0.6891	0.9264	21.4075**	0.9561
Chemical and Chemical Products	0.9114	1.0643	25.9410**	0.9697
Petroleum and Coal Products	1.0103	1.1101	7.1080**	0.7022
Nonmetallic Minerals	0.5368	1.1403	35.2392**	0.9834
Basic Metals	0.6505	1.0266	18.2724**	0.9407
Metal Products	0.5220	1.0166	24.2235**	0.9654
Manufacturing of Machinery (excluding electrical machinery	0.4634	1.0518	23.3275**	0.9628
Electrical Machinery	0.5711	0.9901	23.4756**	0.9632
Transport Equipment	0.2046	1.1498	5.3933**	0.5722
Other Manufacturing	0.5514	1.0591	30.7817**	0.9783

[*/] The sample consisted of 40 countries for which data for V_i (value added in subsector i), L_i (salaried workers in subsector i) and W_i (wages in subsector i) were available for the different manufacturing subsectors in U.N. "The Growth of World Industries". The sample was broken down into 2 subsamples of developed (21 countries) and developing (19 countries) countries. The criterion used was the per capita income with $600 U.S. as the dividing line. The exchange rates used were the "equilibrium" rates available in U.N. "Yearbook of National Accounts Statistics".

**Indicates significant at 0.005 level.
*Indicates significant at 0.05 level.

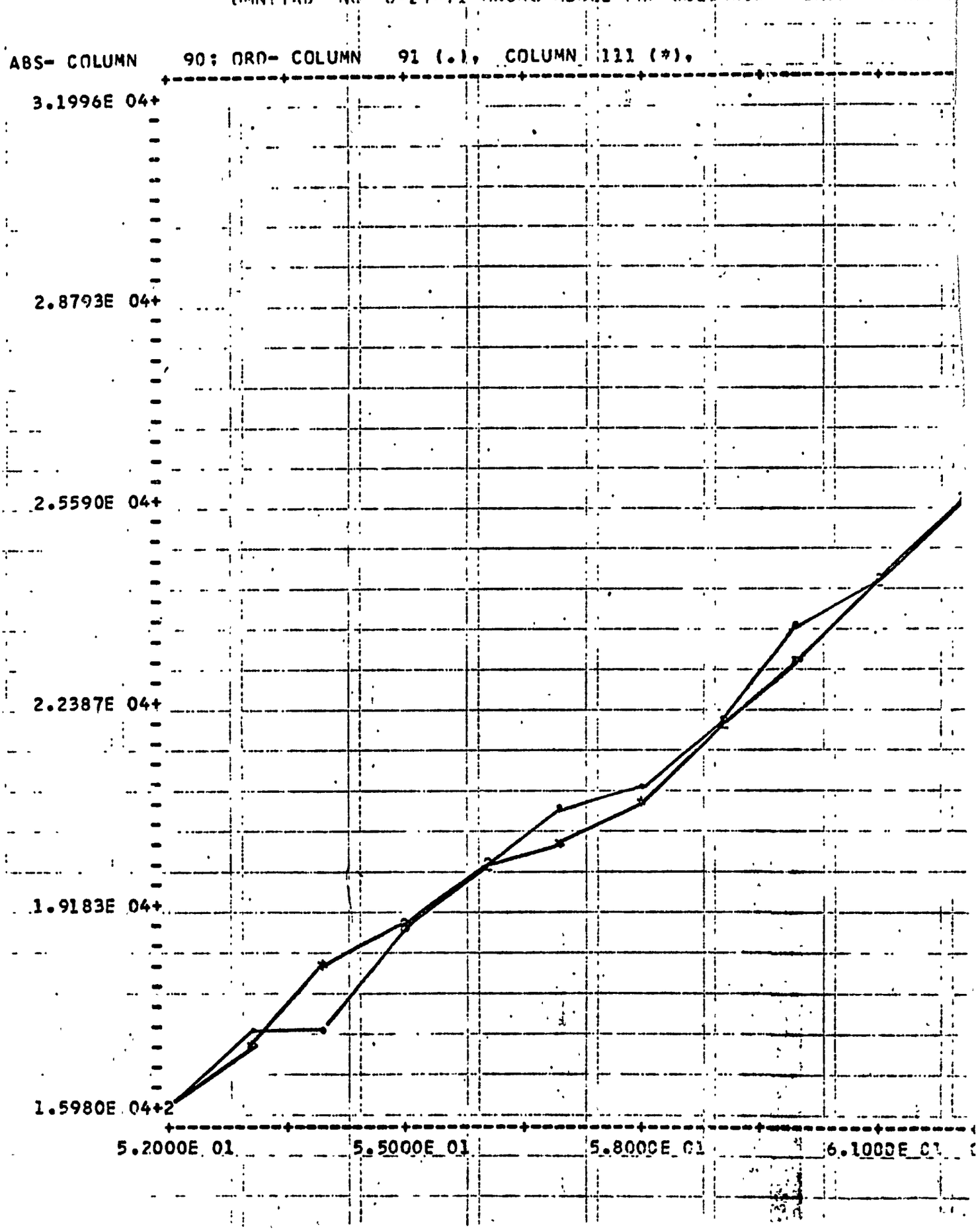
Table E.4. Colombia: Selected estimates of the CES production function for subsectors of manufacturing sector (Sample Used: Developing countries)
(Equation : $\ln(V_i/L_i) = a + b\ln(W_i/L_i)$ */

Subsectors	a	b	t ratio	$\bar{R}^2$
Food	1.3519	1.0089	28.4104**	0.9770
Beverage	1.6167	0.9753	23.1991**	0.9658
Tobacco	1.8834	0.9336	14.4235**	0.9159
Textiles	0.9900	0.9743	24.5749**	0.9694
Clothing and Footwear	0.8979	0.9787	26.3041**	0.9732
Wood and Cork Products	0.8382	0.9591	41.3398**	0.9890
Furniture and Fixtures	0.7868	0.9811	36.7527**	0.9861
Paper and Paper Products	1.1317	0.9791	37.4140**	0.9866
Printing and Publishing	0.6840	0.9720	22.0487**	0.9623
Leather and Leather Products	0.9442	0.9812	29.4670**	0.9786
Rubber Products	1.0583	0.9881	21.6807**	0.9611
Chemical and Chemical Products	1.3020	0.9833	44.2804**	0.9904
Petroleum and Coal Products	1.8268	0.9976	11.2263**	0.8681
Nonmetallic Minerals	0.9885	0.9871	47.6356**	0.9917
Basic Metals	1.0832	0.9863	26.4822**	0.9736
Metal Products	0.8545	0.9977	54.5616**	0.9937
Manufacturing of Machinery (excluding electrical machinery	0.8770	1.0030	32.4915**	0.9823
Electrical Machinery	1.0711	0.9852	28.0579**	0.9764
Transport Equipment	0.6457	1.0084	28.958 **	0.9778
Other Manufacturing	0.9172	0.9956	39.4261**	0.9879

*/ The sample consisted of 40 countries for which data for V_i (value added in subsector i), L_i (salaried workers in subsector i) and W_i (wages in subsector i) were available for the different manufacturing subsectors in U.N. "The Growth of World Industries". The sample was broken down into 2 subsamples of developed (21 countries) and developing (19 countries) countries. The criterion used was the per capita income with $600 U.S. as the dividing line. The exchange rates used were the "equilibrium" rates available in U.N. "Yearbook of National Accounts Statistics".

**Indicates significant at 0.005 level.
*Indicates significant at 0.05 level.

Figure A. Actual and Computed Values of GDP (Y), 1952-1967 (in millions of 1966 pesos, actual



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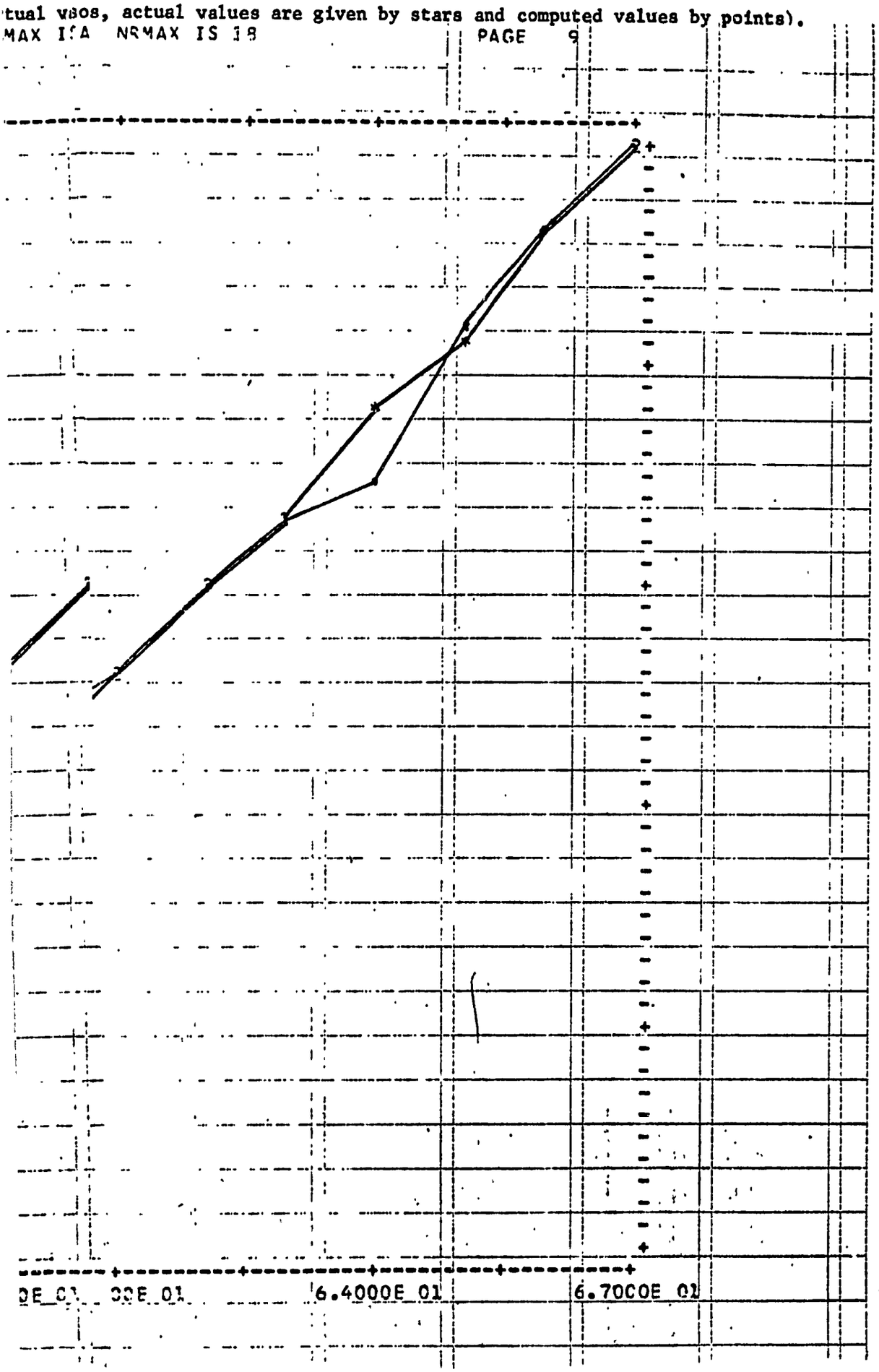

CONTINUOUS INTERFOLDED® MOORE BUSINESS FORMS, INC. 27

CONTINUOUS INTERFOLDED® MOORE BUSINESS FORMS, INC. 27

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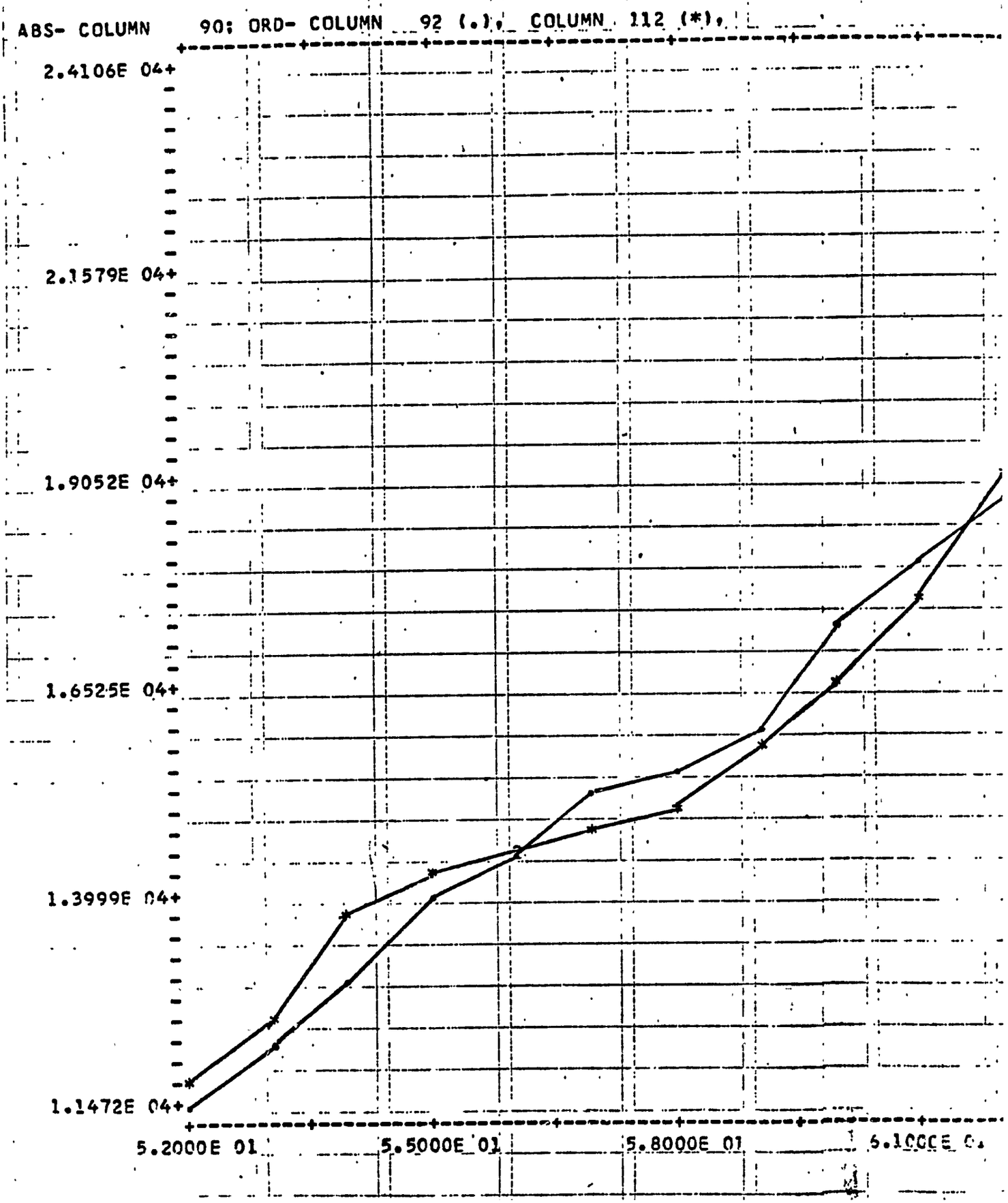
Figure B. Actual and Computed Values of Private Consumption (C^P), 1952-1967 (in millions of 1966

OMNITAB NG 6-27-71 MACRO MODEL FOR COLOMBIA---DATA NRMAX I



(in millions of 1966 pesos, actual values are given by stars and computed values by points)

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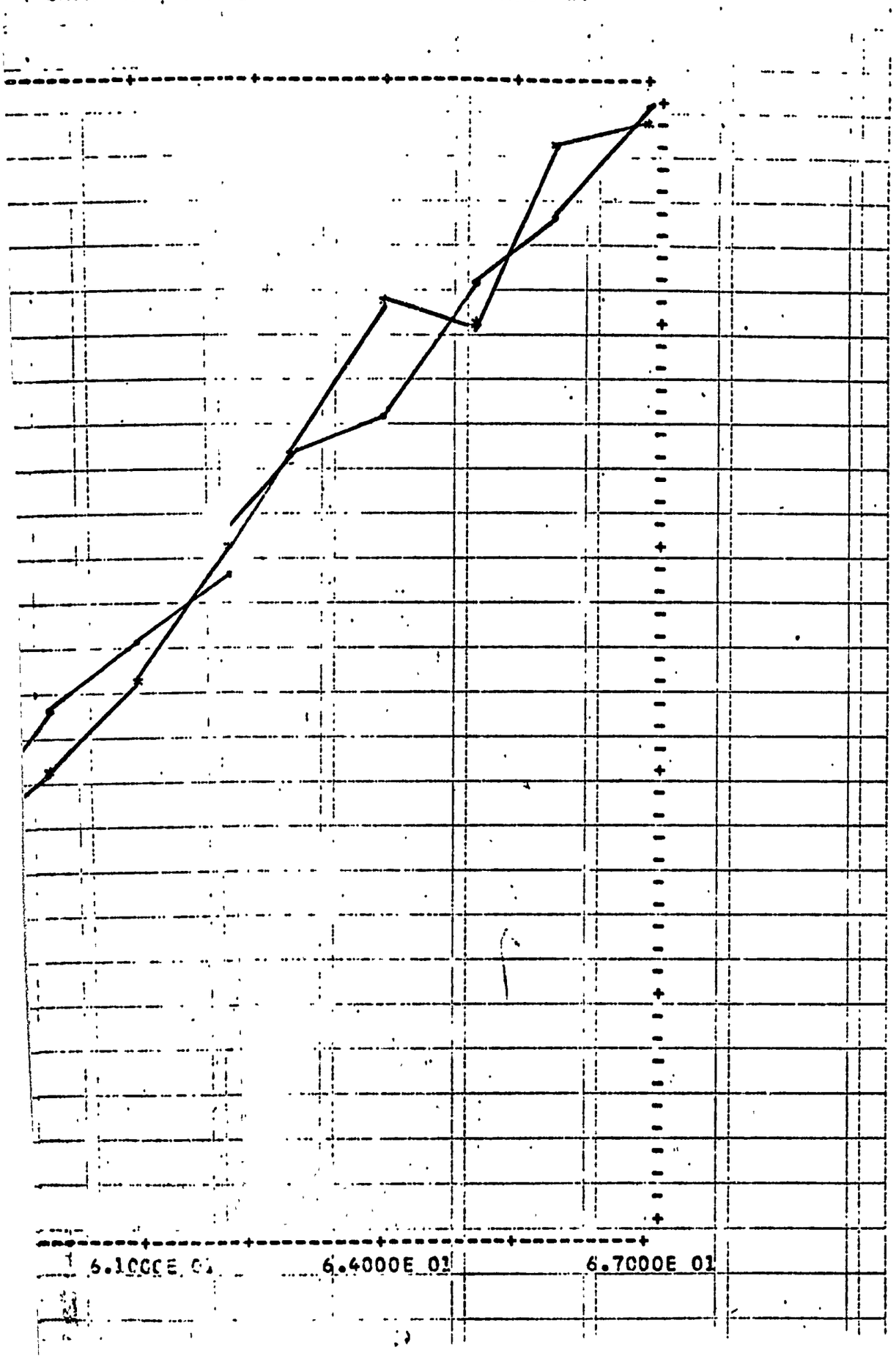
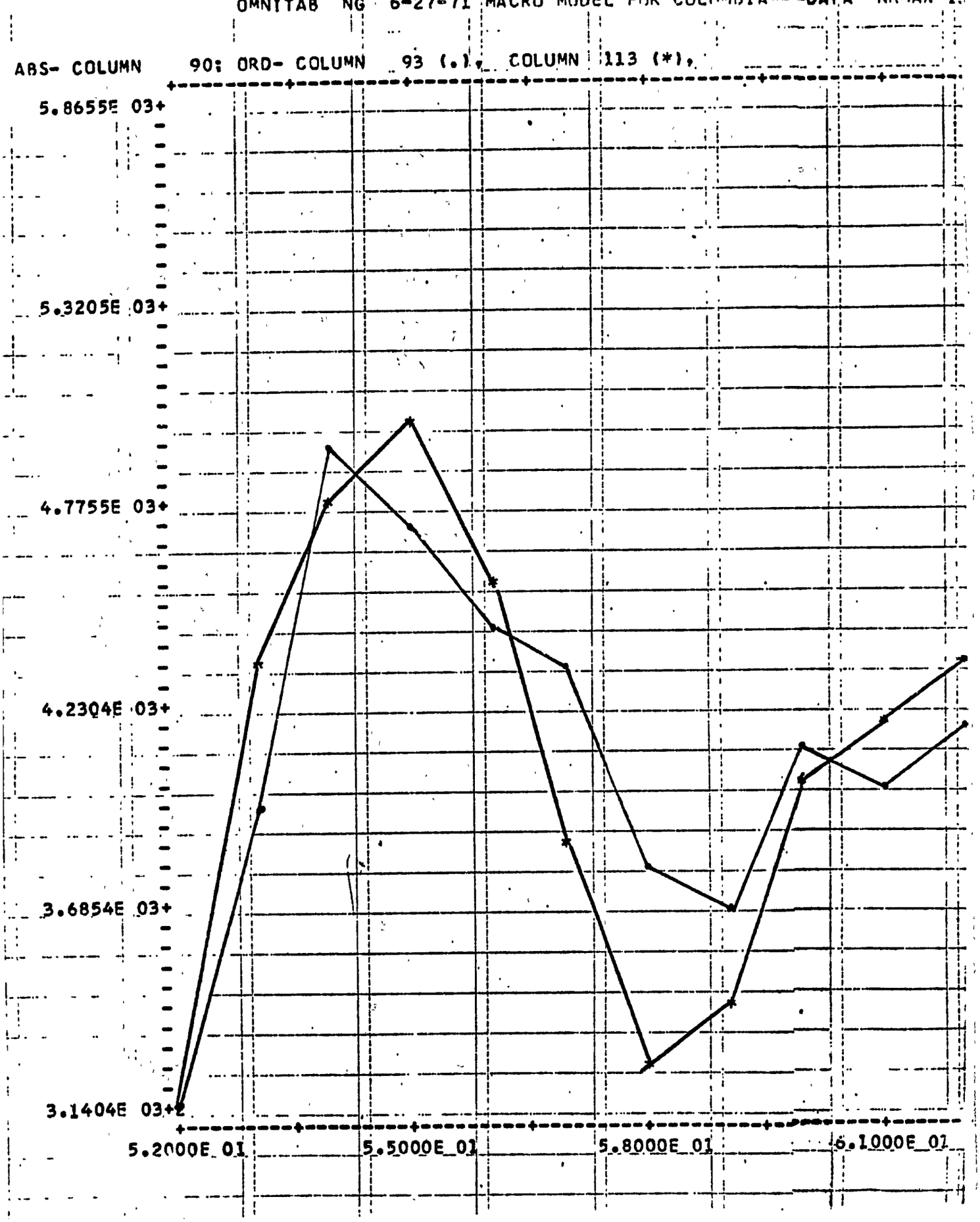


CONTINUOUS INTERFOLDED® MOORE BUSINESS FORMS, INC. 27

Figure C. Actual and Computed Values of Imports (M), 1952-1967 (in millions of 1966 pesos, actua



of 1966 pesos, actual values are given by stars and computed values by points).

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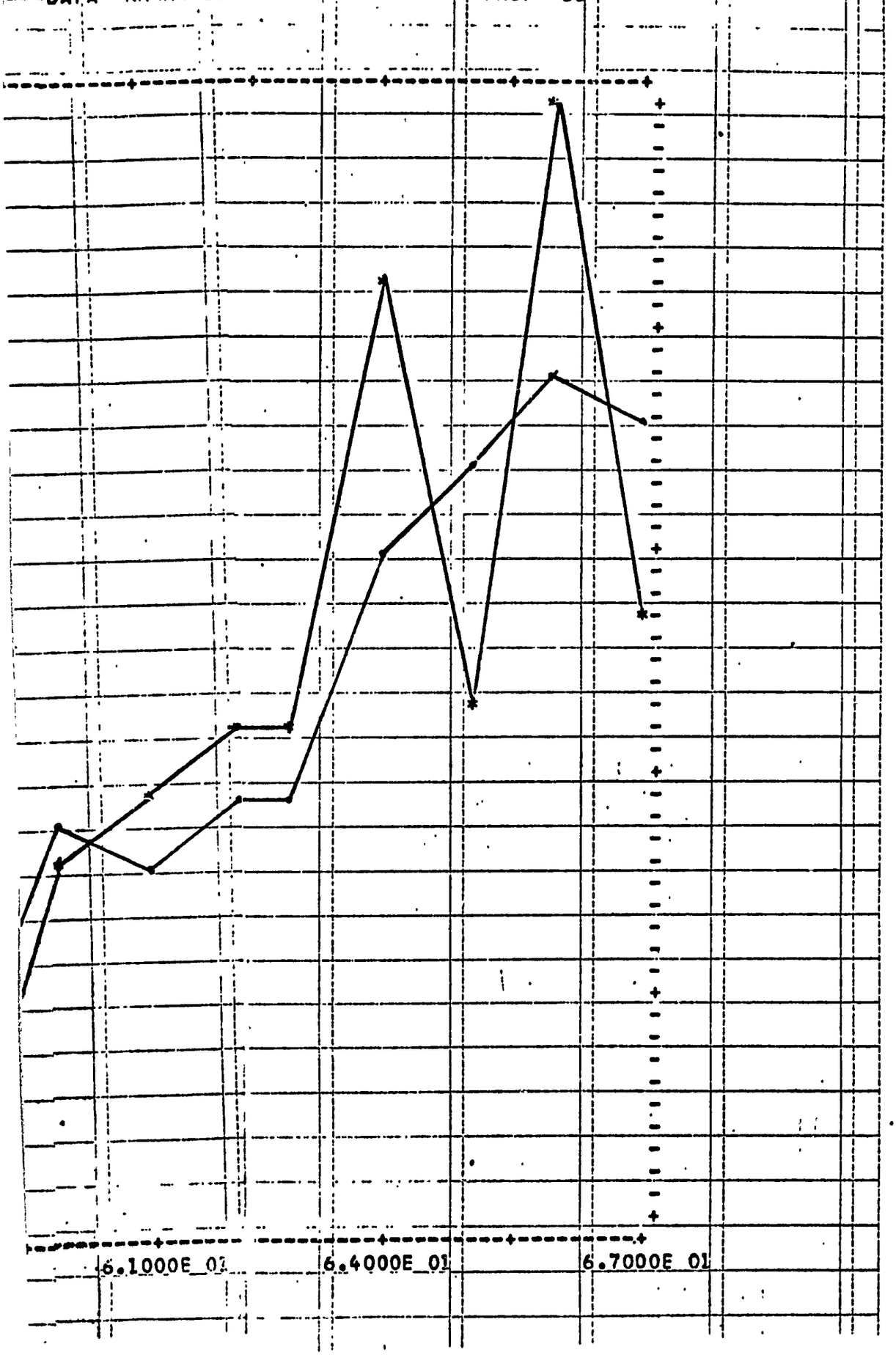

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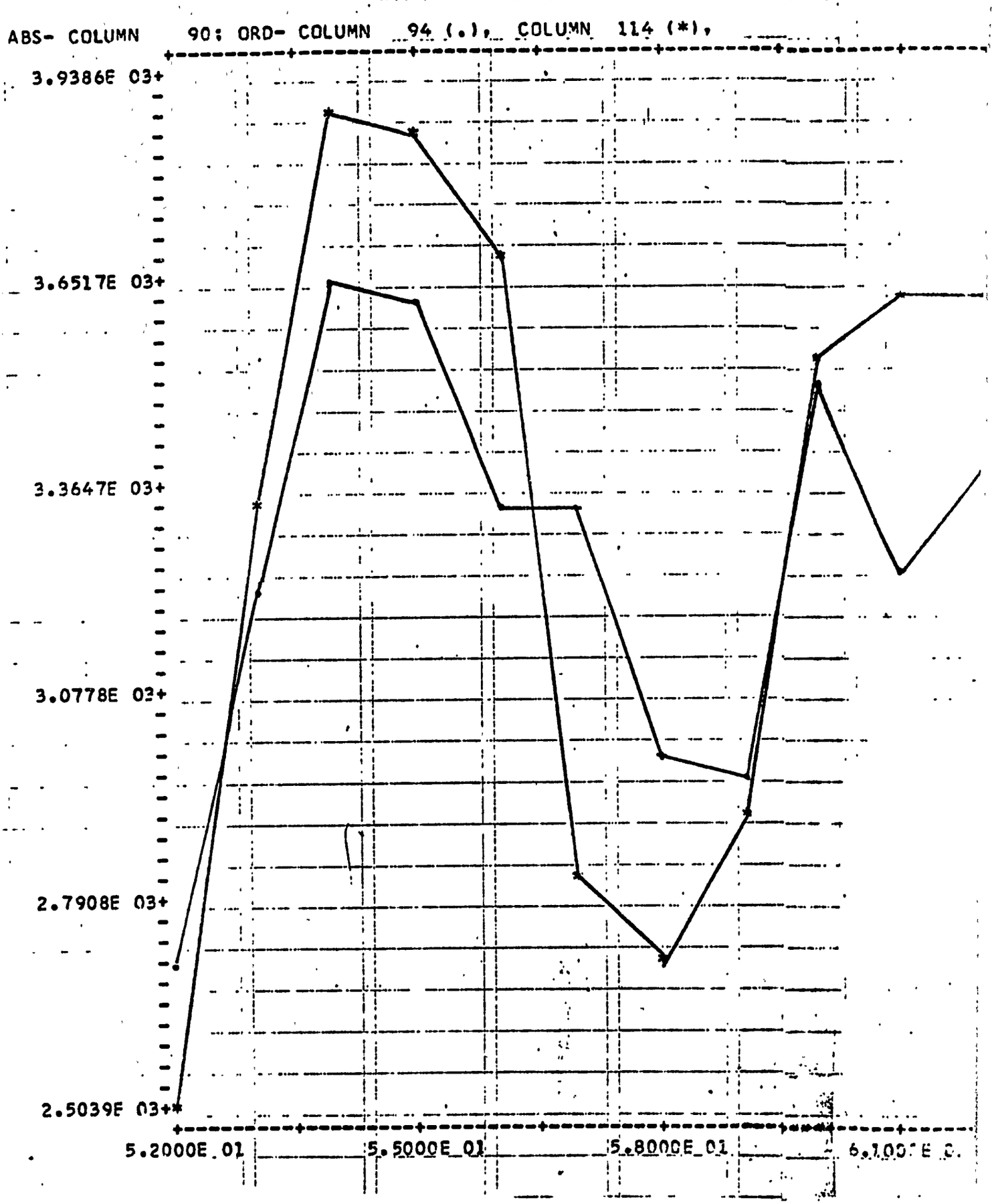
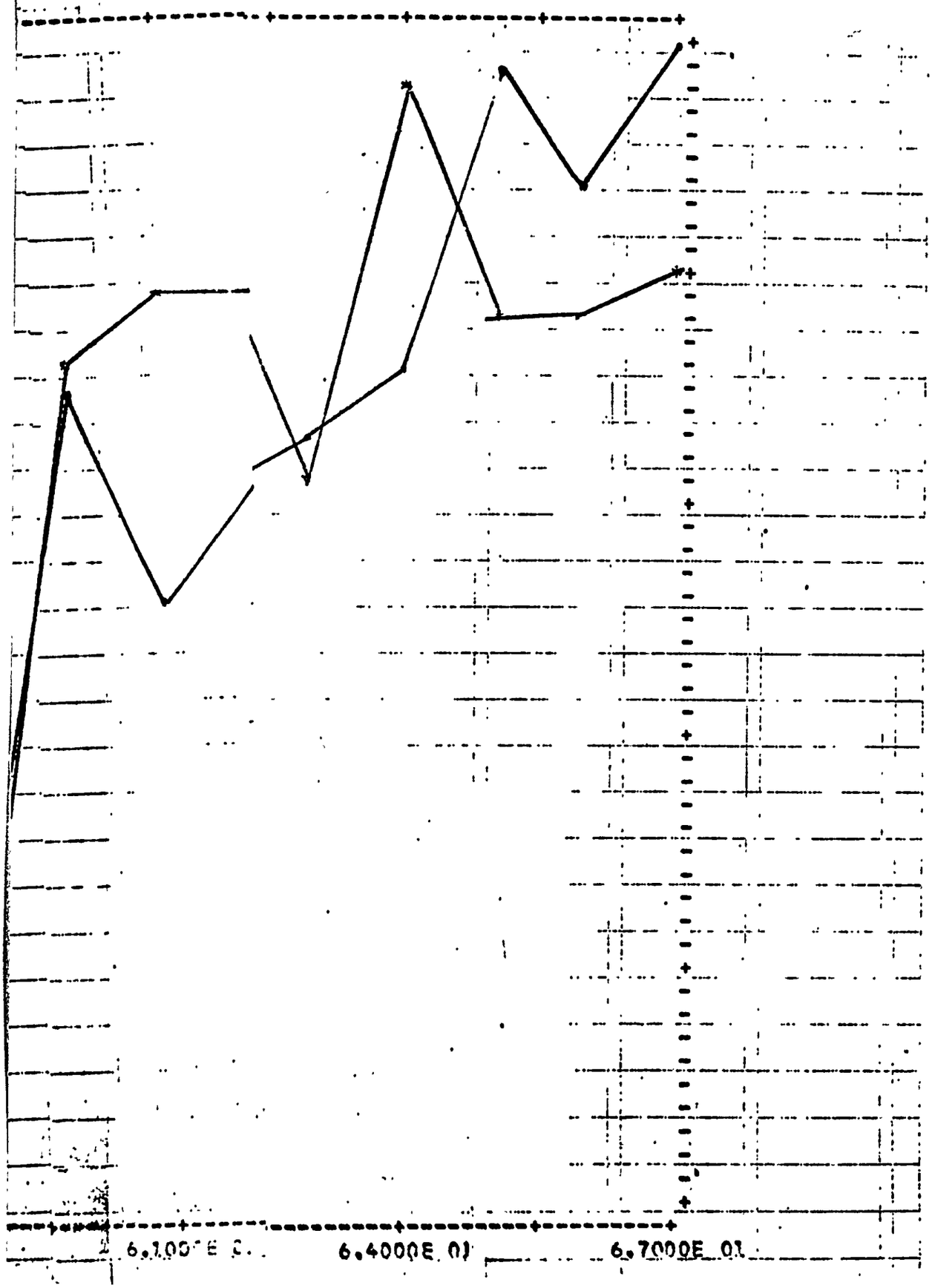
Figure D. Actual and Computed Values of Investment (I^P), 1952-1967 (in millions of 1966 pesos, a

OMNITAB NG 6-27-71 MACRO MODEL FOR COLOMBIA---DATA

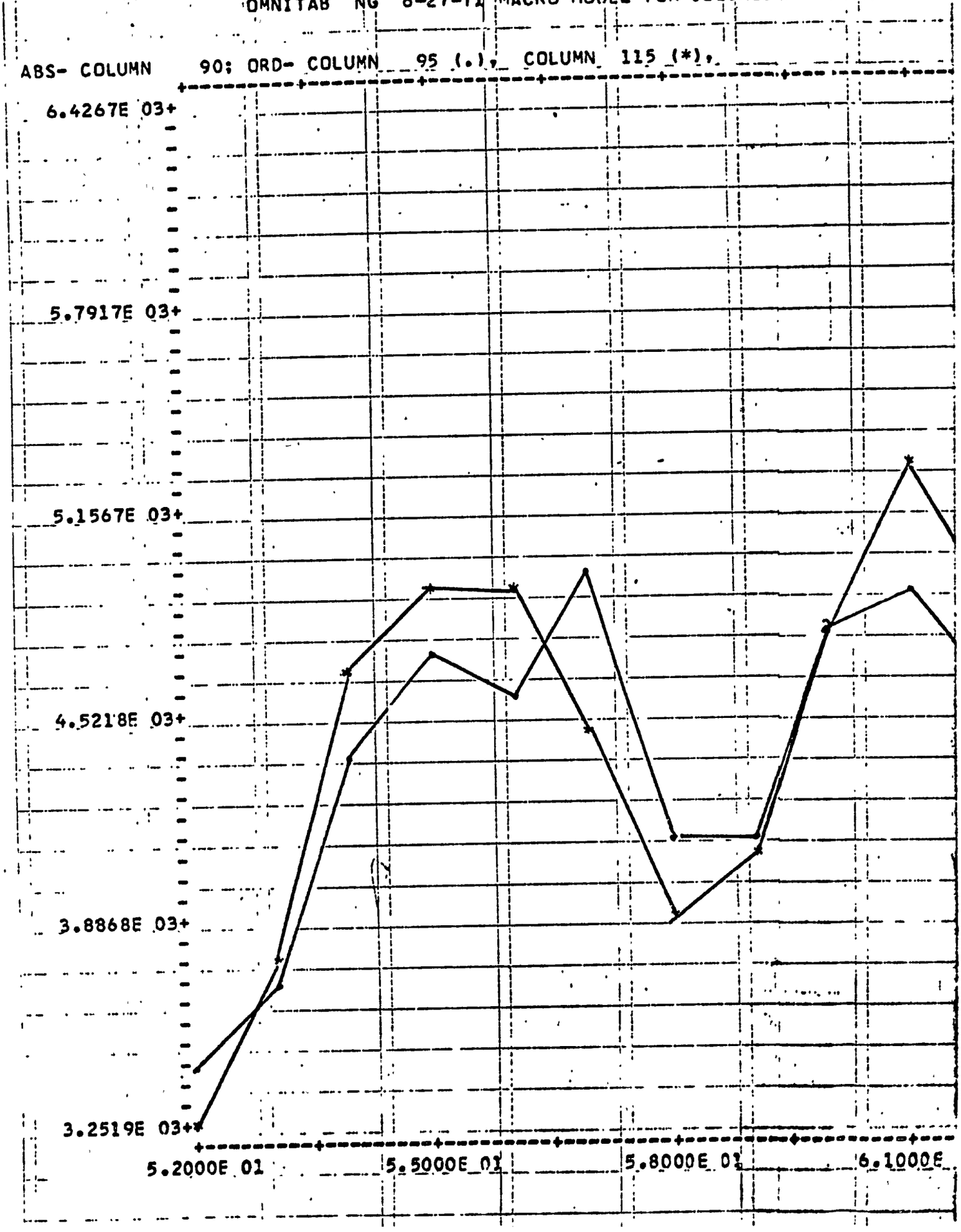


ons of 1966 pesos, actual values are given by stars and computed values by points).



CONTINUOUS INTERVIEW, ASSOCIAT BUSINESS PROGRAMS, INC 2

Figure E. Actual and Computed Values of Investment (I), 1952-1967 (in millions of 1966 pesos)



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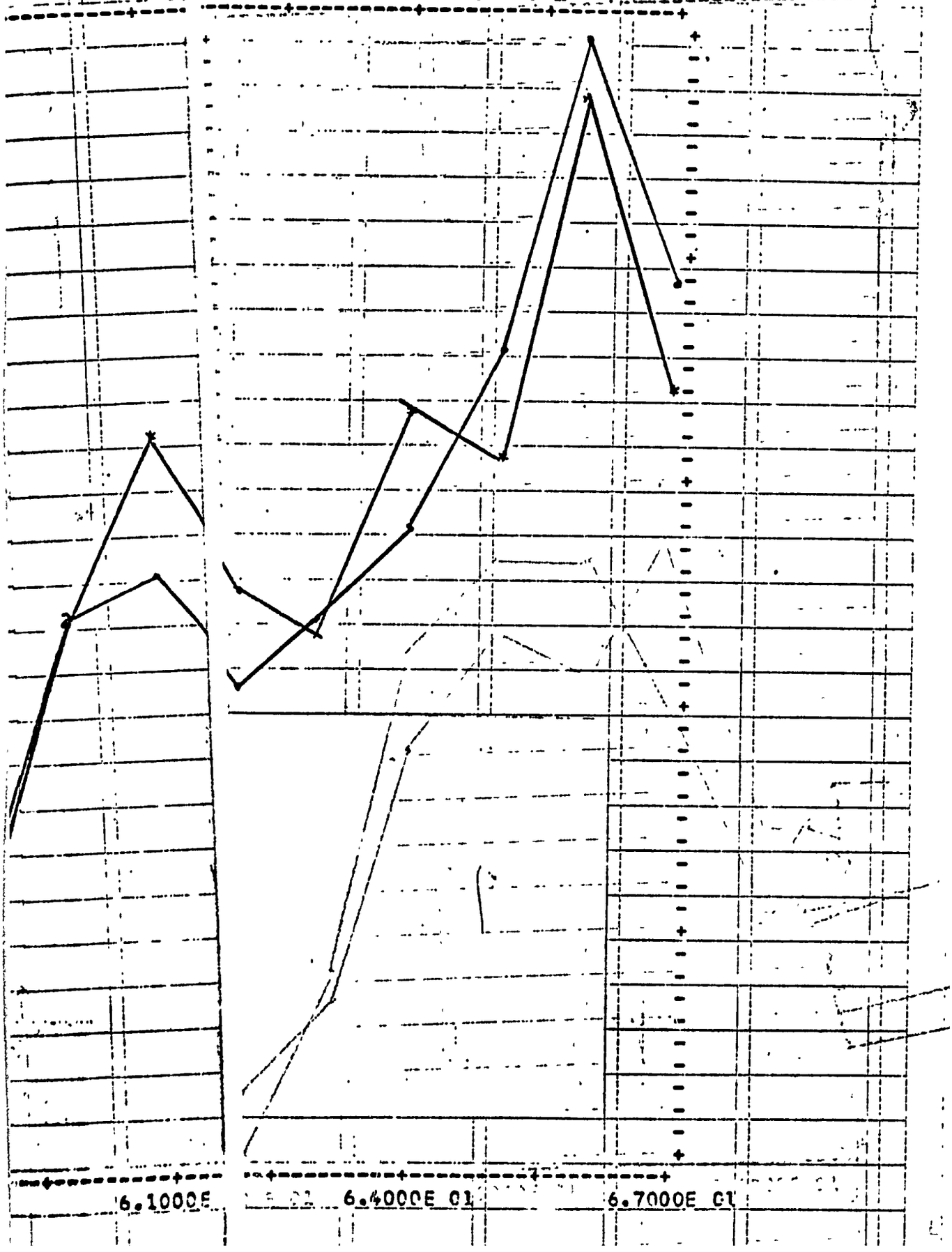
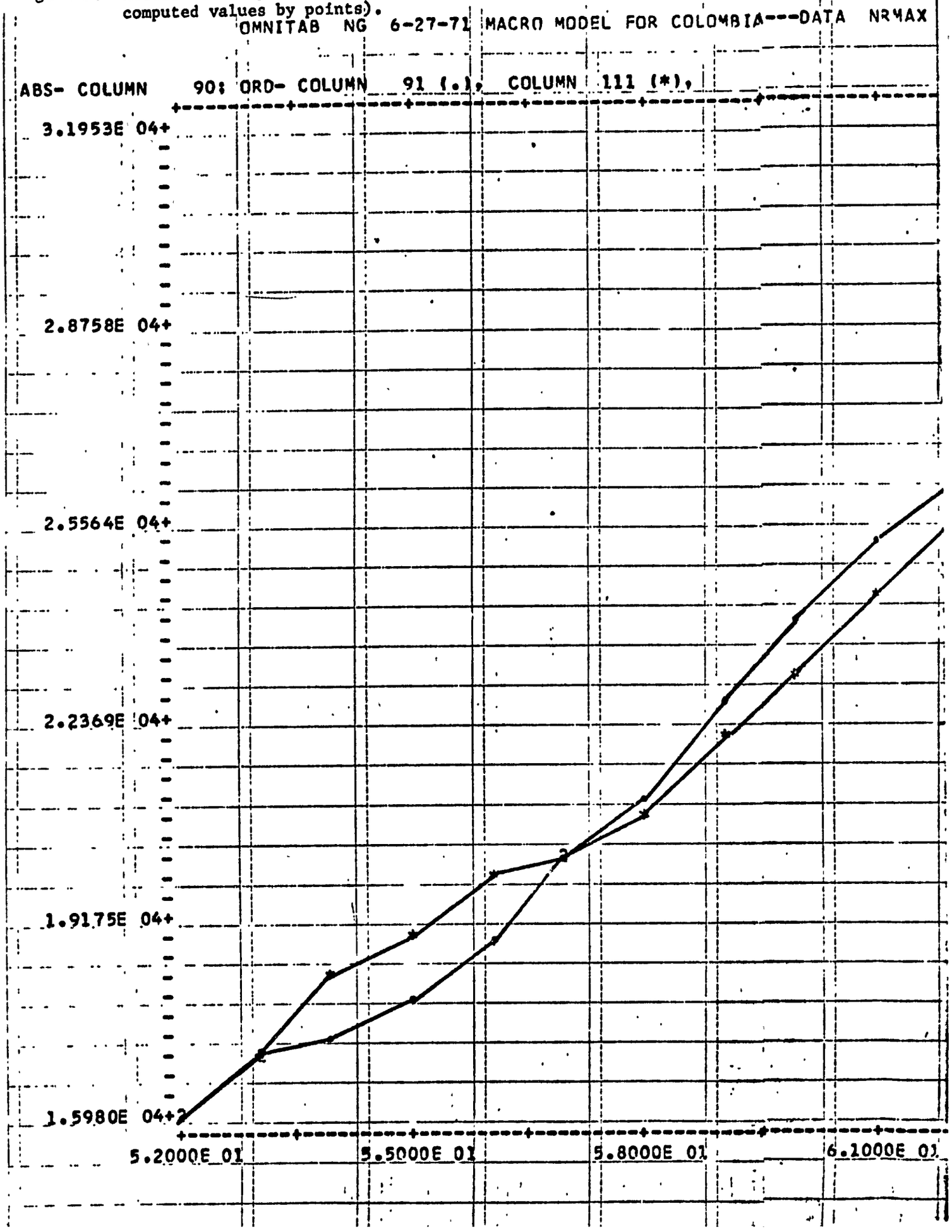


CONTINUOUS INTERFOLDED, MOORE BUSINESS FORMS, INC. 27

Figure F. Actual and Computed Values of GDP (Y) with Lagged Values of Y Endogenously Derived, computed values by points).



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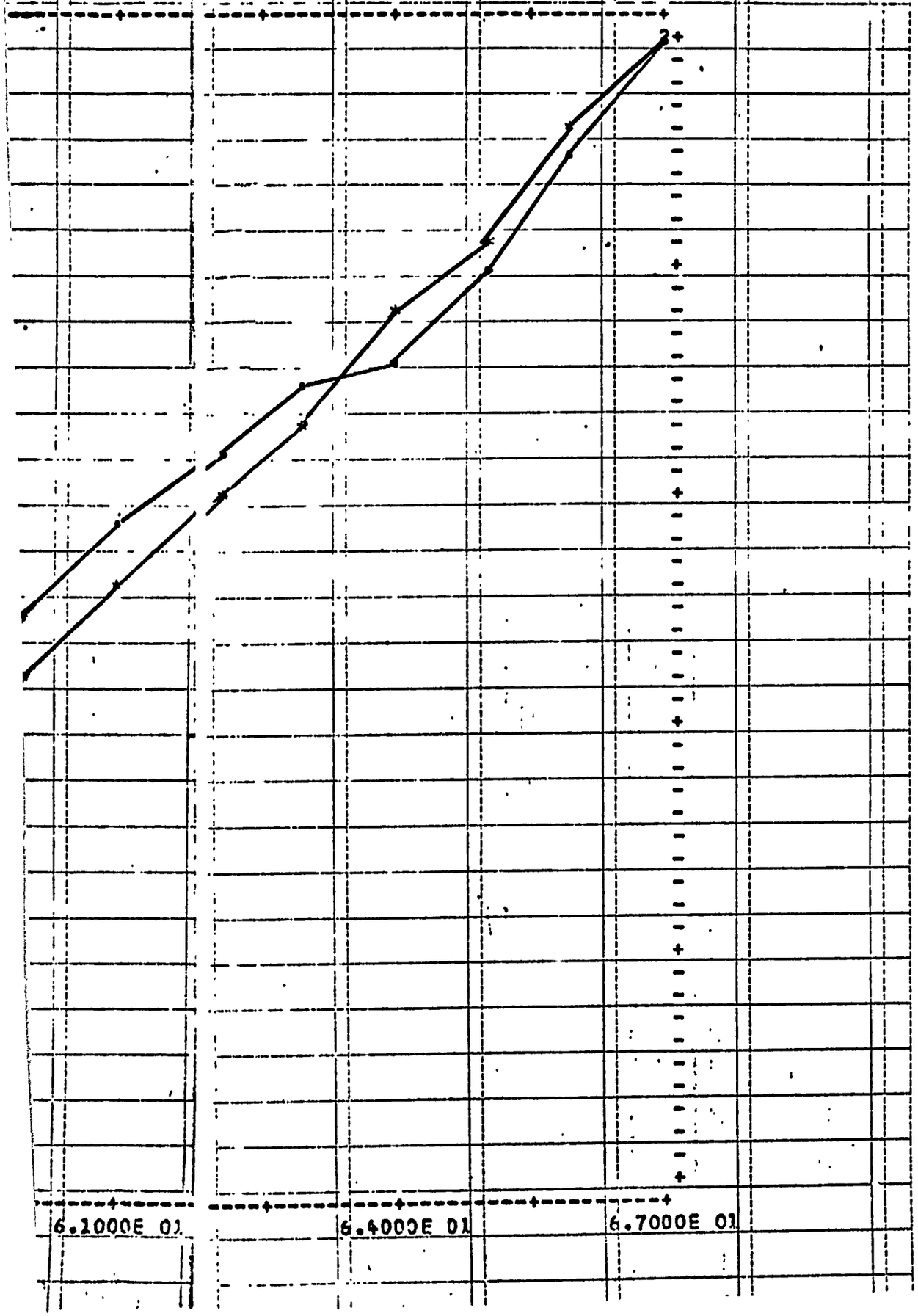
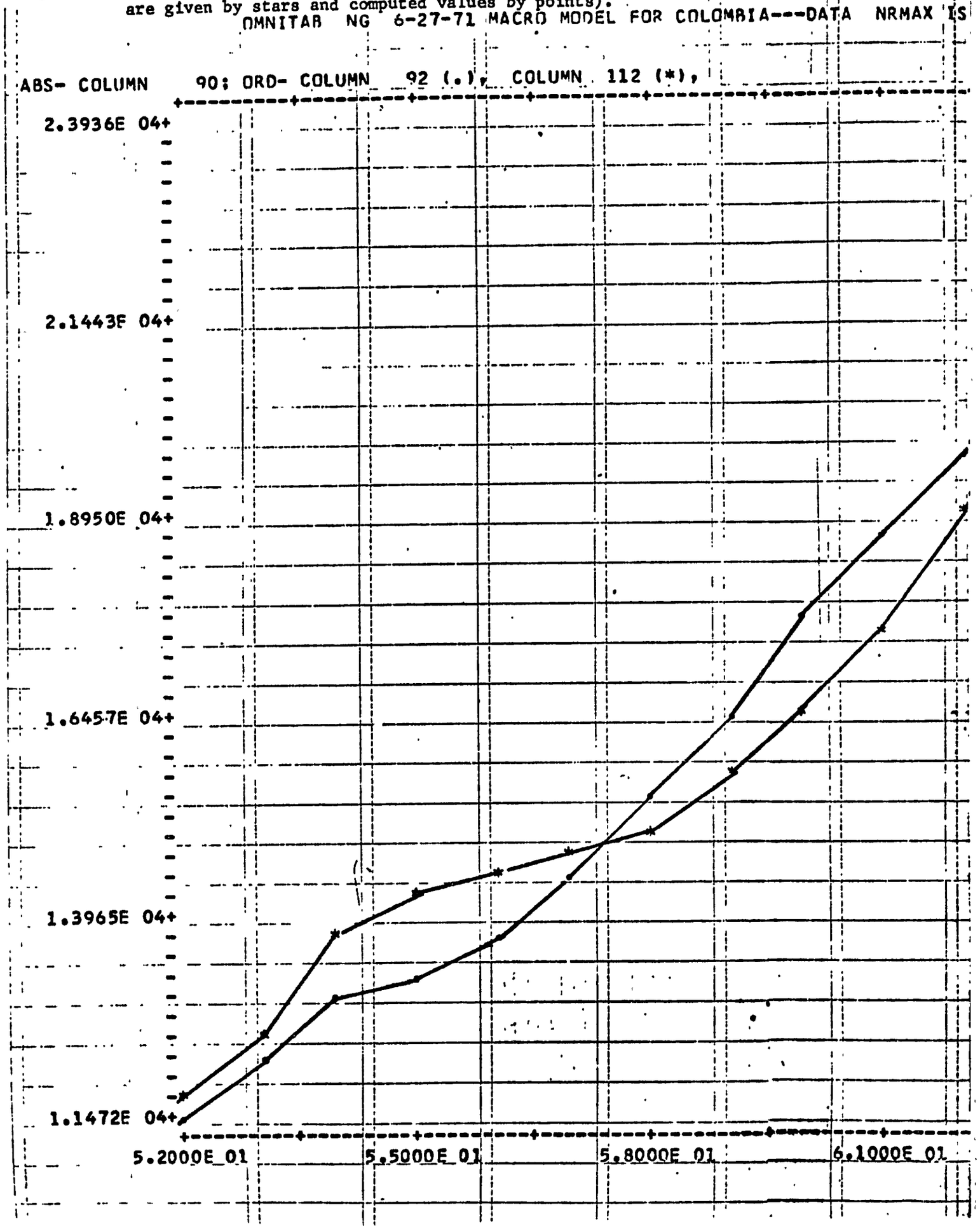


CONTINUOUS INTERFOLDED MOORE BUSINESS FORMS, INC 27

Figure G. Actual and Computed Values of Private Consumption (C^P) with Lagged Values of Y Endogen
are given by stars and computed values by points).



of Y Endogenously Derived, 1952-1967 (in millions of 1966 pesos, actual values

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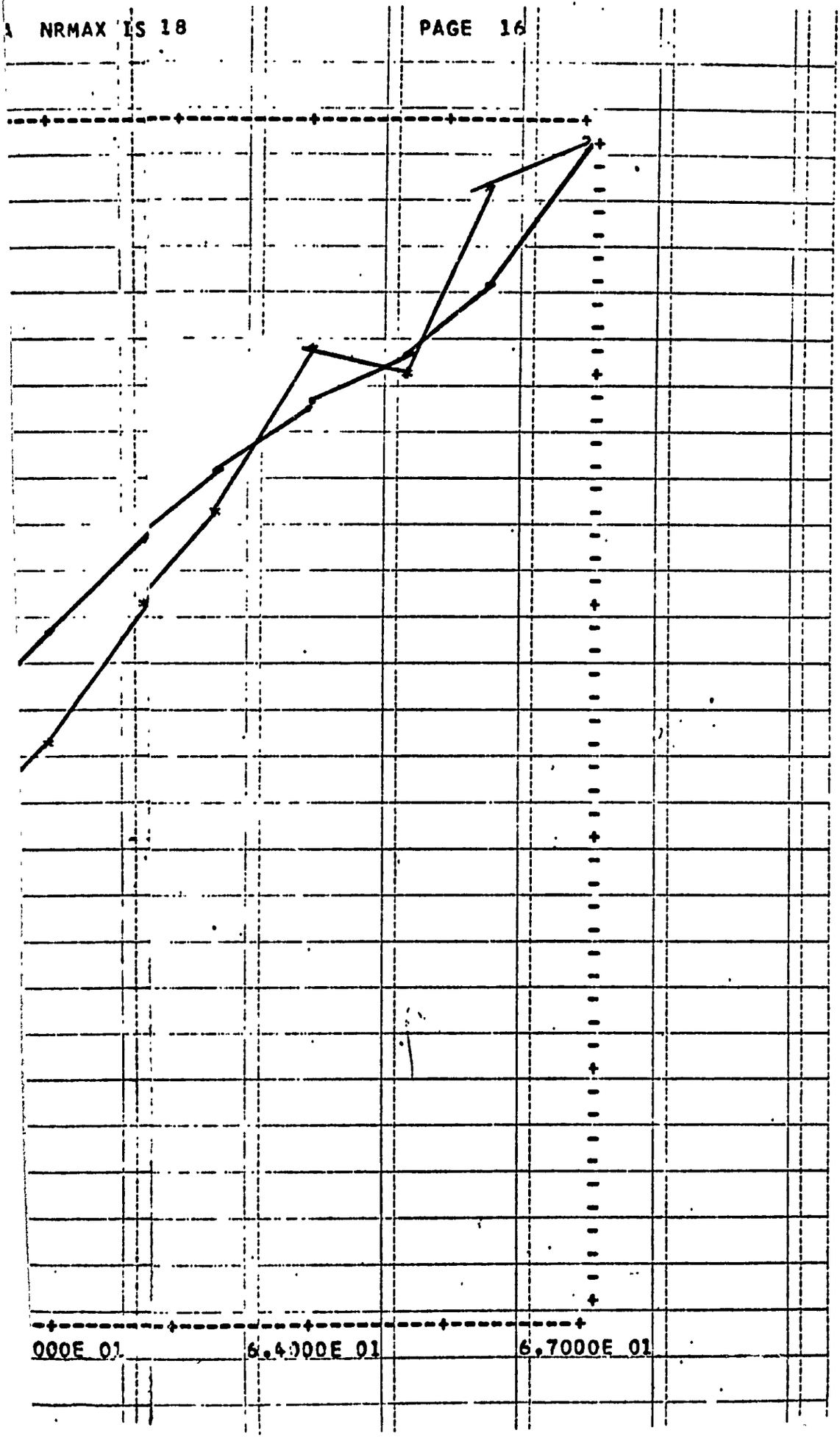
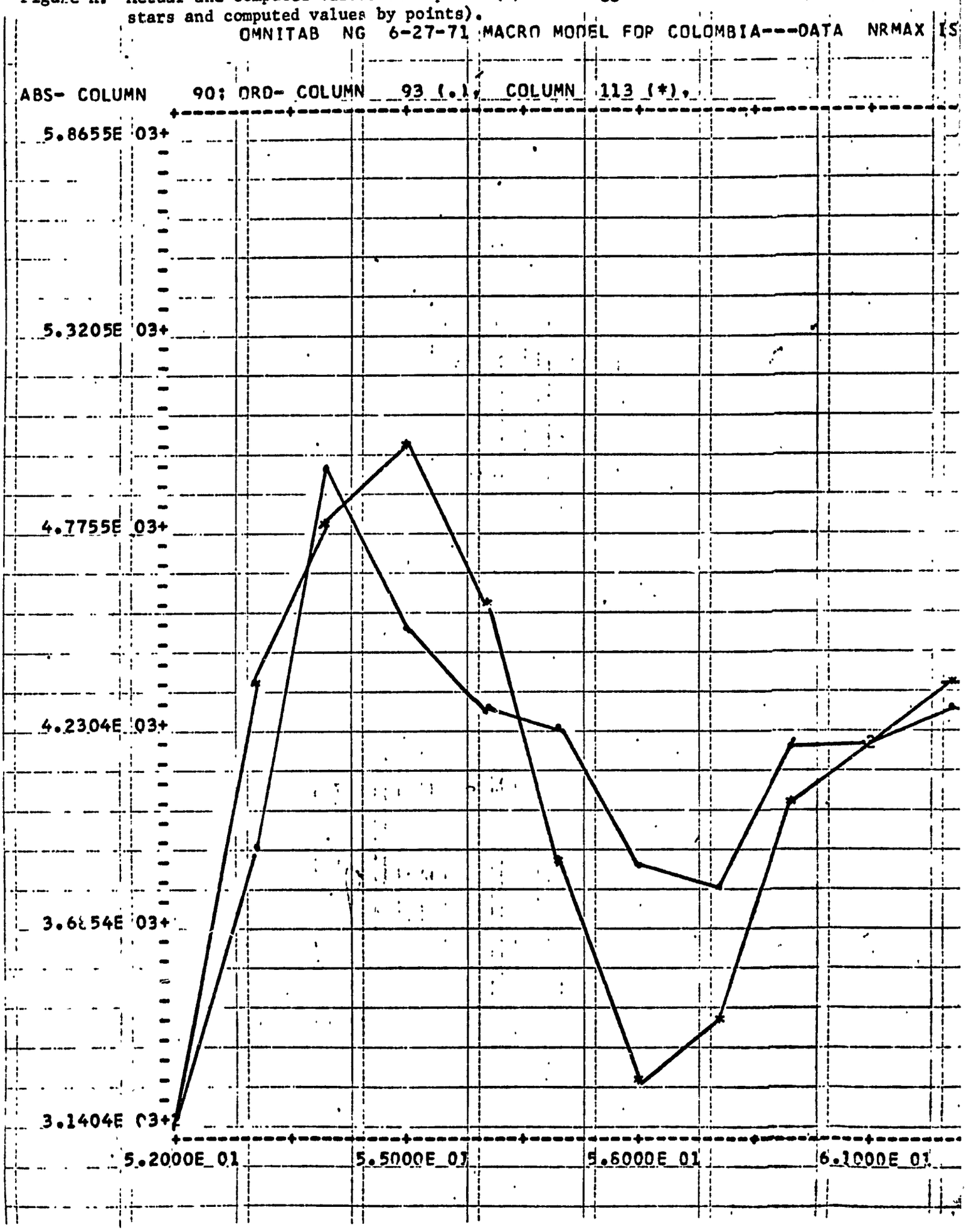
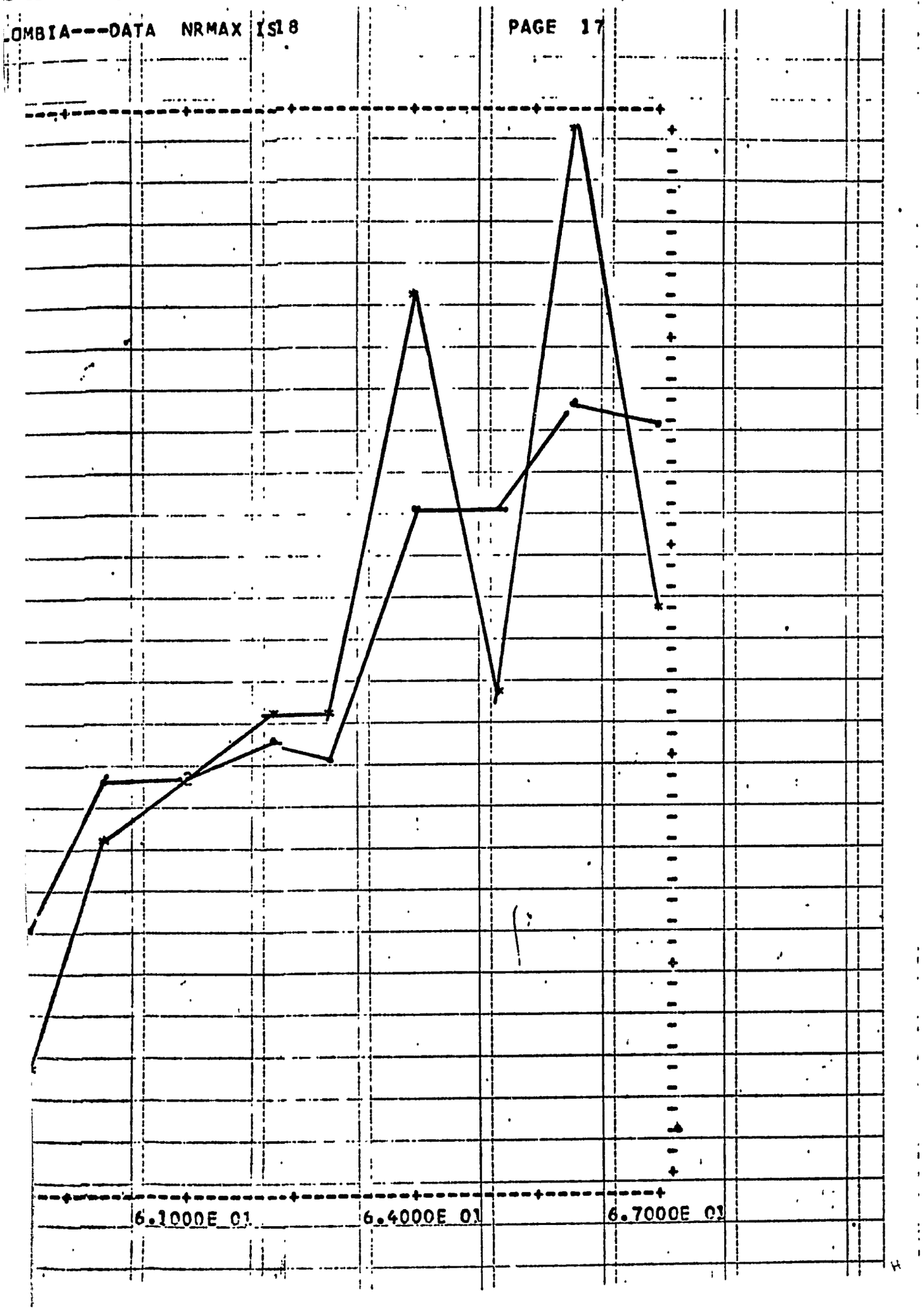


CONTINUOUS INTERFOLDING MOORE BUSINESS FORMS, INC. 27

Figure H. Actual and Computed Values of Imports (M) with Lagged Values of Y Endogenously Derived stars and computed values by points).

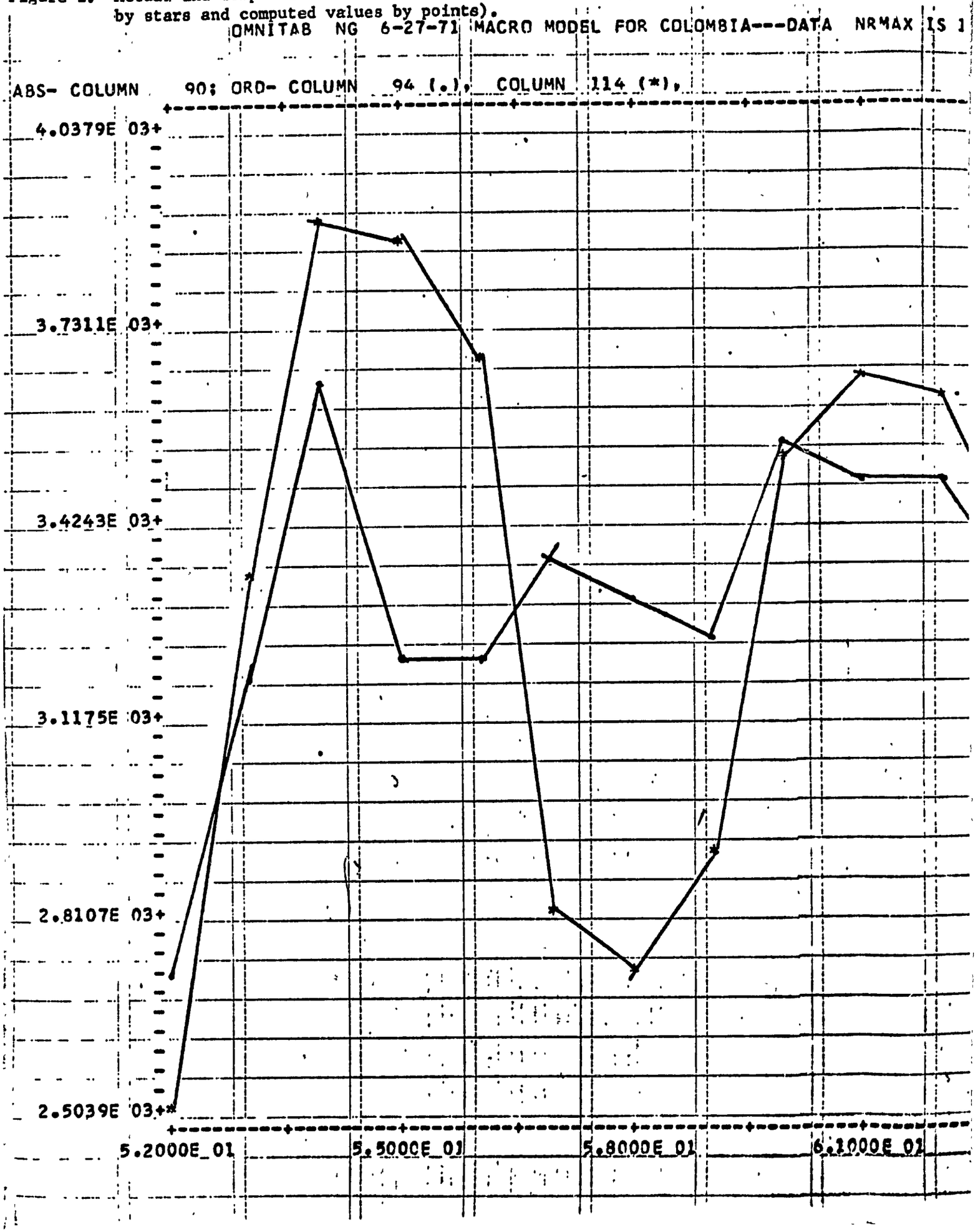


s of Y Endogenously Derived 1952-1967 (in millions of 1966 pesos, actual values are given by



CONTINUOUS INTERFOLDED BY MOORE BUSINESS FORMS, INC. 27

Figure I. Actual and Computed Values of Investment (I^P) with Lagged Values of Y Endogenously Derive by stars and computed values by points).



of Y Endogenously Derived, 1952-1967 (in millions of 1966 pesos, actual values are given

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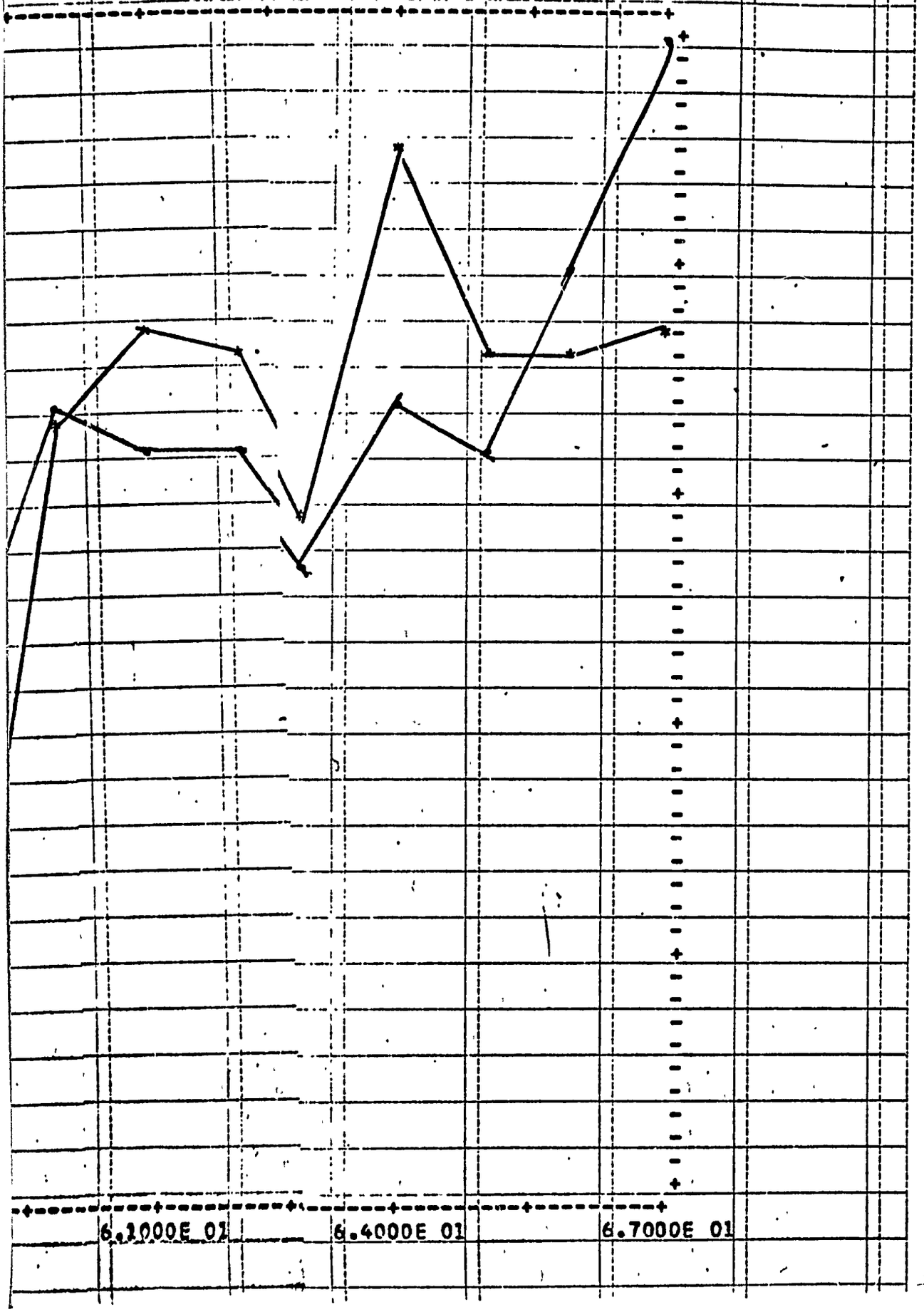
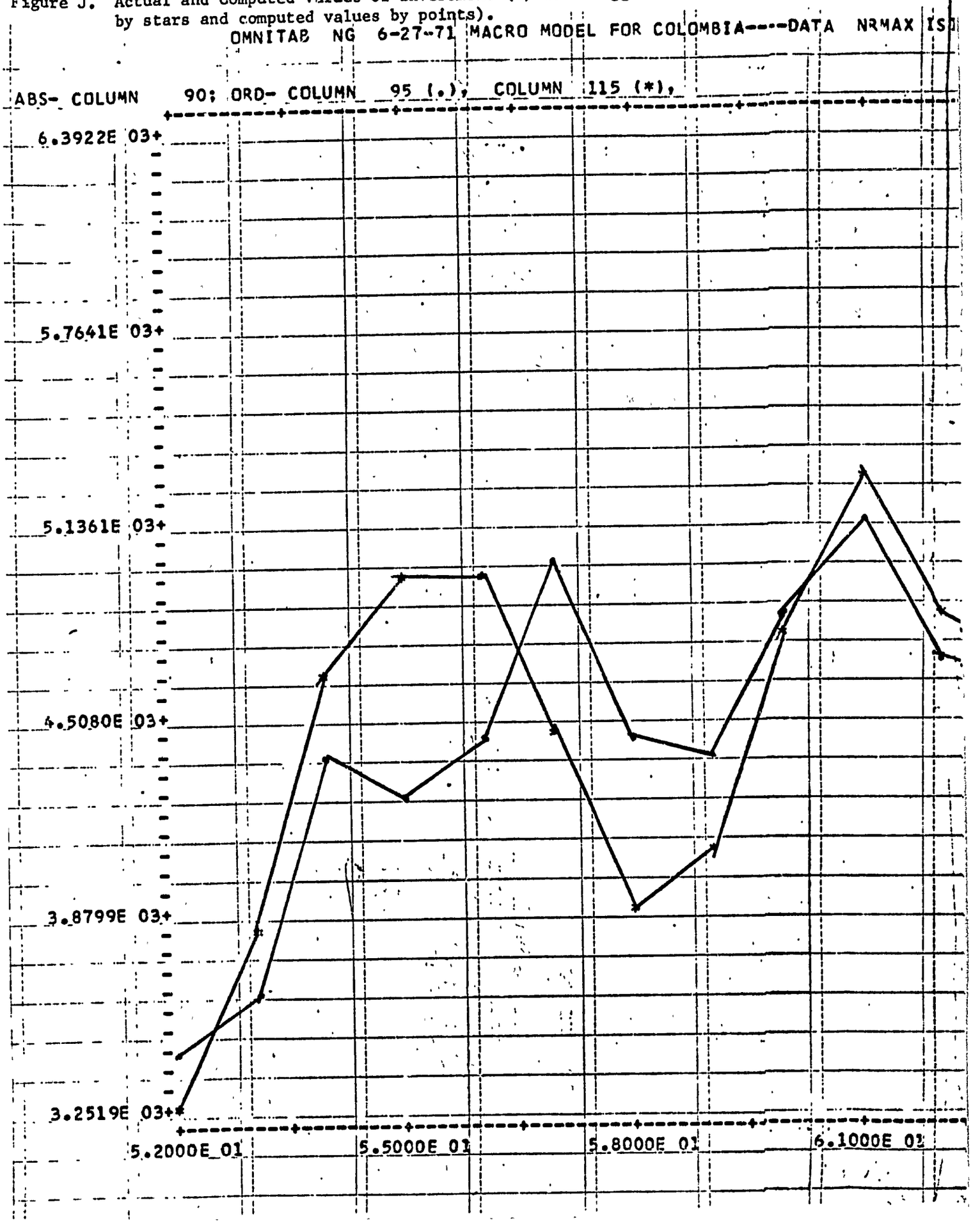


CONTINUOUS INTERFOLDED® MOORE BUSINESS FORMS, INC 27

Figure J. Actual and Computed Values of Investment (I) with Lagged Values of Y Endogenously Derive
by stars and computed values by points).



of Y Endogenously Derive, 1952-1967 (in millions of 1966 pesos, actual values are given

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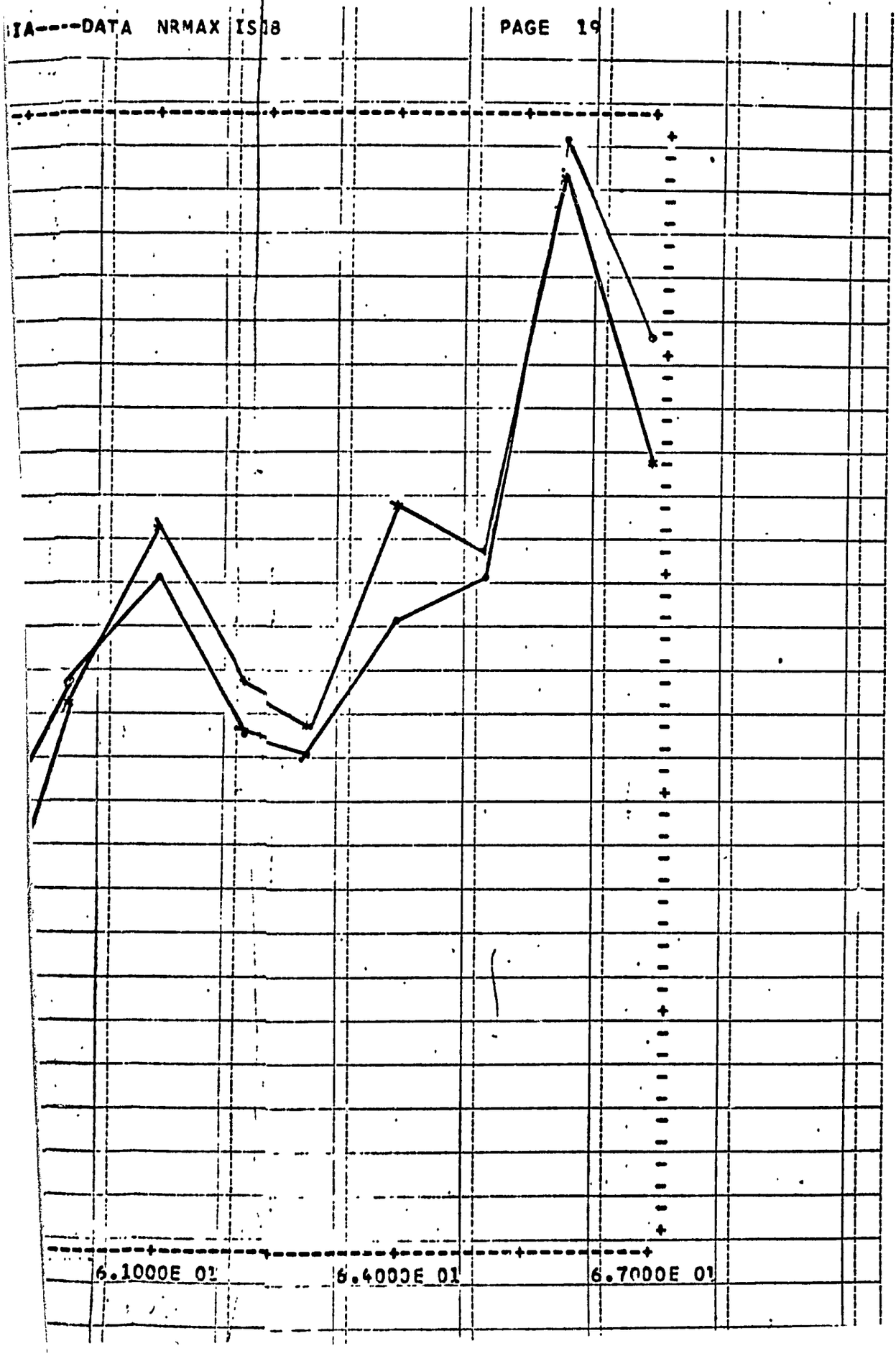

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