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AN ECONOMETRIC MODEL FOR A DEVELOPING ECONOMY: THE CASE OF GREECE *

I. Introduction

Macro-econometric models frequently appear in the literature. They are, however, odinarily concerned with developed economies and only sporadically with underdeveloped or developing ones. In this paper, efforts are being made to present the estimated structure of an econometric model pertaining to Greece. We have selected this country because she performed reasonably well during the last fifteen years, exhibiting an average annual rate of growth of real GNP (1958 prices) of about 6.5%.

Econometric models related to the Greek economy have been developed by D. B. Suits [11], P. Pavlopoulos [9], and I. Adelman and H. B. Chenery [1]. The models at issue attempted, in a way, to describe the functioning of the economy in the fifties. From among these, the Suits model seems to be more realistic in the sense that is considerably disaggregated and based on more elaborate economic assumptions. Nevertheless, serious shortcomings characterize this model. These may be classified into the following: (a) Transformations of market demand into production categories were «based on the gross composition of individual productive activity and [made] no allowance for interindustry flows» [10, p. 74], due to the unavailability of an input-output table of Greece in 1963. Consequently, the components of these equations together with coefficients of other equations based upon the former are of questionable value. (b) Tests pertinent to serial independence of the disturbance terms were not performed. Hence, one can not really evaluate the estimated coefficients as being significant or not, because he is unable to appraise their standard errors in the first place. On the other hand, we should not overlook the possibility of the existence of autocorrelated disturbances (cf. the Durbin–Watson and von Neumann statistics in [9] and [1]). (c) Annual observations covering the period

1951–61 were employed. That is, years prior to 1954 connected with the transitive period of the economy were taken into account by Suits (cf. fn. 2). Thus, the decision to rely on rather low values of various variables that dominated the early years of his sample further aggravated the existing multicollinearity problem, and seriously affected the estimated coefficients. (d) Ordinarily least squares (or O. L. S.) regressions were used throughout his research in spite of the inclusion of jointly dependent variables among the regressors in a number of equations.

The statistical limitations of [11] render its estimated structure unreliable and of little practical importance. Consequently, to improve upon it is perhaps a more meaningful contribution to the economic development of Greece than constructing a new model. To this end the remainder of the present paper is devoted. Thus, the above mentioned shortcomings are taken care of; equations (7) — (9), (12) and (35)— (40—our numbering—are modified; a new equation (eq. (21)) is added; value added equations, notably eqs. (26) — (28), rely upon the detailed information of a 50 × 50 input-outpout table [6]; equations exhibiting significantly autocorrelated disturbances are reestimated (cf. eqs. (2), (4), (5), (8) - (10), (13), (15), (29), and (35)) by the aid of a trchnique developed by H. Theil and A. L. Nagar [14]; attempts to distinguish between endogenous and exogenous components of tax yields are being made; and finally key findings obtained by Suits [11] and us are compared.

The econometric model, whose estimated structure is given in section V, employs 71 variables and consists of 42 structural equations, in variables and coefficients classified as follows : (a) six consumer demand equations; (b) six investment demand equations; (c) two stock (inventory) equations; (d) six import demand equations; (e) one export equation; (f) twelve production and income equations, seven of which are definitional equations, three are transformations of market demand into production categories, and two are behavioral equations; and (g) nine institutional equations, two of which are definitional. Attempts to introduce the monetary sector were not fruitful. They failed to yield reasonable coefficients in sign and magnitude. In this respect the model is similar to [11] as being Keynesian.

II. The Data

The basic data used in this analysis originate mostly from the National Statistical Service of Greece; The Center of Planning and Economic Research in Athens, Greece; and the Greek Ministry of Economic Coordination [1]. The estimation procedure is based on a sample of 12 annual observations, namely years 1954–65 [2]. This was based on 1958 constant prices, with the exception of the institutional part for which current prices were used. Data unavailability or unreliability imposed a restriction and forced to use shorted time series in certain cases [3].

III. Problem of Estimation

In the process of our empirical analysis we were faced with two serious problems. First, the high degree of intercorrelation among various explanatory variables, which prevented us from using more sophisticated equations. The multicollinearity was so severe (irrespective of the elimination of abnormal annual observations prior to year 1954) that even when a third explanatory variables was used in an equation, it effected the previous corectly introduced variables in such a way that they entered afterwards with wrong signs.

Second, the serial interdependence of the distrurbances. One of the possible reasons for the problem of autocorrelated sisturbances in the omission of certain important explanatory variables in the equation to be estimated. This, however, was inevitable in our case since we were forced to omit certain variables entering with wrong signs due to multicollinearity. Whenever the hypothesis on independently distributed disturbances was rejected, the standard errors of the coefficients were regarded with suspicion, since they were underestimates of the true errors and might be misleading with respect to the importance of the estimated parameters. To make sure of the significance of our results we attempted to remove the nuisance when it appeared by (a) assuming that the disturbances were generated by a first order Markov autoregressive scheme; (b) estimating the first order autocorrelation coefficient r from the residuals by using a formula suggested by Theil and Nagar [14 pp. 803ff]; and (c) recomputing the equation in question [4]. These reestimated equations appear in the final estimated structure of the model (their variables) are characterized by a prime superscript), while the ones that were replaced by them are presented as Appendix for comparison.

IV. Methods of Estimation

Two methods of estimation of coefficients are utilized : (a) O.L.S. regressions for equations exclusively employing predetermined explanatory variables; and (b) two-stage least squares (or 2. S.L.S.) otherwise. The estimation techniques are explained in the standard literature of econometrics. With reference to 2. S.L.S. the estimation procedure relies on F. M. Fisher's block recursive system [5] because of the existence of a problem of degrees of freedom (29 predetermined variables versus 12 annual observations). Thus, five blocks of equations are constructed. In the first block which depends on predetermined variables equations (7) - (13) and (19) - (21) are included. Hence, they are calculated by means of O.L.S. The 2. S.L.S. method is utilized in the remaining blocks. In the second and third blocks, we include equations (1) - (6) and (14), respectively. We tread the latter separately because the available number of observations—seven—is not sufficient for a simultaneous estimation of this equation with others. Equations (15) - (18) and (30) are treated together as a fourth block, while the institutional equations and equation (29), which are forced through the origin, comprise the fifth block.

Adopting criteria developed by Fisher [5], we introduce the following predetermined variables (n — 2 at the most, where in stands for the total number of observations) in the first stage of a 2. S. L. S. equation : (i) variables GC, GI, GΔST, GW, TAI, and TAPI enter into every equation; [5] (ii) predetermined variables appearing in a specific block are utilized by equations in that block; and (iii) variables DAP7, ΣTAP_{t-1}, ΣTM_{t-1} and L_{t-1}, PAF, PLA, ΣTC_{t-1} take part in blocks two and five, respectively, because the number of variables under (i) and (ii) that participate in these two blocks is less than n - 2.

V. List of Equations

At the right of each estimated equation we list the adjusted coefficient of multiple determination $\bar{R}^2$; and the Durbin–Watson, d, statistic or the von Neumann ratio, δ^2/S^2, for serial correlation [6,7]. Estimated standard errors of coefficients are given in parentheses below their coefficients. The estimated equations are tabulated into the following five groups according to implicit economic interrelationships.

A. Consumption Functions :

1. $CF = 15{,}426 + \underset{(.0045)}{.2374Y} \qquad \bar{R}^2 = .995 \quad \delta^2)S^2 = 1.62$

2. $CT' = 587 + \underset{(.0071)}{.0020Y'} + \underset{(.0079)}{.0185L'_{t-1}} \qquad \bar{R}^2 = .714 \quad \delta^2)S^2 = 1.98$

3. $CC = -2{,}384 + .1316Y + .0179L'_{t-1} \quad \bar{R}^2 = .0978 \quad \delta^2)S^2 = 2.86$
$\qquad (.0429) \qquad (.0474)$

4. $CH' = 8{,}709 + .1008Y' + .0549L'_{t-1} \quad \bar{R}^2 = .999 \quad \delta^2)S^2 = 2.51$
$\qquad (.0080) \qquad (.0096)$

5. $CDF' = -1{,}665 + .0924Y' + .0127L'_{t-1} \quad \bar{R}^2 = .977 \quad \delta^2)S^2 = 1.70$
$\qquad (.0402) \qquad (.0222)$

6. $COS = -1{,}025 + .1636Y + .0524L'_{t-1} \quad \bar{R}^2 = .992 \quad \delta^2)S^2 = 2.84$
$\qquad (.0357) \qquad (.0396)$

B. Investment and Stock Functions :

7. $IA = -3{,}086 + .1926GA'_{t-1} \quad \bar{R}^2 = .698 \quad d = 1.91$
$\qquad (.0372)$

8. $IM' = 1{,}180 + .3253GM'_{t-1} = .0502\Sigma IM'_{t-1} \quad \bar{R}^2 = .639 \quad d = 1.50$
$\qquad (.0574) \qquad (.0385)$

9. $IT' = 495 + .0722Y' - .1497\Sigma IT'_{t-1} \quad \bar{R}^2 = (-) \quad d = 1.37$
$\qquad (.1600) \qquad (.1925)$

10. $IMN' = 202 + 1.2315GMN'_{t-1} - .4499\Sigma IMN'_{t-1} \quad \bar{R}^2 = .465 \quad d = 1.92$
$\qquad (.4134) \qquad (.1792)$

11. $IOS = 771 + 243.7099t \quad \bar{R}^2 = .896 \quad d = 2.02$
$\qquad (23.4629)$

12. $IH = -5{,}311 + .2242TSD'_{t-1} + 1.0327P \quad \bar{R}^2 = .956 \quad d = .74$
$\qquad (.0310) \qquad (.9961)$

13. $\Delta AST' = -1{,}140 + .7306DAP7' - .5522\Sigma TAP'_{t-1} \quad \bar{R}^2 = .869 \quad d = 2.65$
$\qquad (.1090) \qquad (.1316)$

14. $\Delta MST = 894 + .0571GM - .2717\Sigma IM_{t-1} \quad R^2 = (-) \quad \delta^2)S^2 = 1.98$
$\qquad (.2118) \qquad (.4097)$

C. Import and Export Functions :

15. $MMC' = -1{,}430 + .0932Y' \quad \bar{R}^2 = .660 \quad \delta^2)S^2 = 1.86$
$\qquad (.0174)$

16. $MMNC = -5{,}712 + .8760GM \quad \bar{R}^2 = .991 \quad \delta^2)S^2 = 1.91$
$\qquad (.0233)$

17. $MAF = 936 + .0357Y - .5110PAF \quad \bar{R}^2 = .700 \quad \delta^2)S^2 = 1.76$
$\qquad (.0077) \qquad (1.078)$

18. $MLA = 991 + .0014Y - .4610PLA \quad \bar{R}^2 = .478 \quad \delta^2)S^2 = 1.96$
$\qquad (.0017) \qquad (.1560)$

19. $MPWDS \quad 1{,}202 - .0639DCP_{t-1} - .1116\Sigma TC_{t-1} \quad \bar{R}^2 = (-) \quad d = 1.45$
$\qquad (.2439) \qquad (.2473)$

20. $MOIL = 167 - .0211DOIL_{t-1} - .0290\Sigma TOIL_{t-1} \quad \bar{R}^2 = (-) \quad d = 1.57$
$\qquad (.0450) \qquad (.1003)$

21. $X = 687 + .3390X_{t-1} - 1291.7913RXP + \cdot 1321DGX \quad \bar{R}^2 = .956 \quad d = 2.74$
$\qquad (.2180) \qquad (1671.7092) \qquad (.0400)$

(–) Negative when corrected for degrees of freedom.

D. Production and Income Functions:

22. $GNP = C + I + (\Delta AST + \Delta MST) + (X - M) + (GC + (GI + G\Delta ST) + GW$

23. $C = CF + CT' + CC + CH' + CDF' + COS$

24. $I = IA + IM' + IT' + IMN' + IOS + IH'$

25. $M = MMC' + MMNC + MAF + MLA + MPWDS + MOIL$

26. $GNA = (.558\ CF + .901\ CT + .943\ CC + .998\ CH + .967\ CDF + .970\ COS) +$
$+ (.937\ CON + .810\ PE) + \Delta MST + (.477\ XAF + .642\ XA + .213\ XT +$
$+ .719\ XSL + .869\ XF + .556\ XMIN + XMET + XPG + .816\ XCP +$
$(+ .973\ XTXL + .952\ XMISC.) - M + (.946\ GC + GI + G\Delta ST) + GW$

27. $GA = (.442\ CF + .099 CT + .057 CC + .002 CH + .033\ CDF + .030\ COS) +$
$+ (.063\ CON + .190\ PE) + \Delta AST + (.523\ XAF + .358\ XA +$
$+ .787\ XT + .281\ XSL + .131\ XF + .444\ XMIN + .184\ XCP +$
$+ .027\ XTXL + .048\ XMISC) + .054\ GC$

28. $GM = (.399\ CF + .773\ CT + .743\ CC + .071 CH + 719 CDF + .323\ COS) +$
$+ [(.784\ CON)k + (.561\ PE)\ (1-k)]\ I + \Delta MST + (.223\ XAF +$
$+ .491\ XA + .054\ XT + .519\ XSL + .697\ XF + .146\ XMIN +$
$+ 176 XMET + .666\ XPG + .594\ XCP + .811\ XTXL + .118\ XMISC) +$
$+ .282\ GC$

29. $DEP' = .0790\ (GNA\text{-}TI)'$ (.0056) $\bar{R}^2 = .979$ $\delta^2/S^2 = 1.80$

30. $W = -654 + .3239\ (GNA\text{-}TI)$ (.0190) $\bar{R}^2 = .960$ $\delta^2/S^2 = 1.41$

31. $YP = GNP - DEP - TI$

32. $YNA = YP - .98\ GA$

33. $Y = YP - TP - TPI - TSS$

E. Institutional Equations:

34. $TIT = .5969\ CT$ (.0368) $\bar{R}^2 = .979$ $\delta^2/S^2 = 1.69$

35. $TIOC' = .0234\ (C - CT)'$ (.0053) $\bar{R}^2 = .969$ $\delta^2/S^2 = 2.49$

36. $TCD = .1146\ M$ (.0107) $\bar{R}^2 = .959$ $\delta^2/S^2 = 1.35$

37. $TTR = .0210\ (G\ W + GNA)$ (.0020) $\bar{R}^2 = .992$ $\delta^2/S^2 = 2.25$

38. $TI = TIT + TIOC + TCD + TTR + TAI$

39. $TPI = .0352\ YNA$ (.0007) $\bar{R}^2 = .997$ $\delta^2/S^2 = 2.48$

40. $TPY = TPI + TAPI$

41. $TSS = .1574\ (GW + G)$ (.0066) $\bar{R}^2 = .984$ $\delta^2/S^2 = 1.94$

42. $TR = .0970\ (GW + GNA)$ (.0053) $\bar{R}^2 = .971$ $\delta^2/S^2 = 1.48$

VI. List of Variables

All variables employed in the present model are cited here. Variables pertaining to current time periods are represented without subscripts, while those lagged one period are identified by the subscript «t–1».

A. Current endogenous variables :

Symbol		Description
1.	CF	Consumer expenditure for food and beverages.
2.	CT	Consumer expenditure for tobacco.
3.	CC	Consumer expenditure for clothing.
4.	CH	Consumer expenditure for housing: rent and water charges fuel and light; household operation.
5.	CDF	Consumer expenditure for durable furniture.
6.	COS	Consumer expenditure for other services.
7.	C	Total private consumer expenditure.
8.	Y	Personal disposable income.
9.	IA	Fixed investment in agriculture.
10.	IM	Fixed investment in manufacturing.
11.	IT	Fixed investment in transportation.
12.	IMN	Fixed investment in mining.
13.	IOS	Fixed investment in other services.
14.	IH	Fixed investment in housing.
15.	I	Total private fixed investment.
16.	ΔAST	Changes in privately held agricultural stocks.
17.	ΔMST	Changes in privately held manufacturing stocks.
18.	GM	Value added in manufacturing.
19.	MMC	Imports of consumer manufactured goods.
20.	MMNC	Imports of nonconsumer manufactured goods.
21.	MAF	Imports of agricultural products : animal and fishery products.
22.	MLA	Imports of agricultural products : «luxuries».
23.	MPWDS	Imports of plant products with domestically produced substitutes.
24.	MOIL	Imports of edible oils.
25.	M	Imports of commodities.
26.	X	Exports of commodities.
27.	GNP	Gross national product.
28.	GNA	Nonagricultural value added.
29.	GA	Agricultural value added.

30.	DEP	Depreciation
31.	TIT	Yield from indirect taxes on tobacco.
32.	TIOC	Yield from indirect taxes on the other consumer goods.
33.	TCD	Yield from custom duties.
34.	TTR	Yield from transaction taxes.
35.	TI	Total yield from indirect taxes.
36.	W	Private wage and salary income.
37.	YP	Personal income.
38.	YNA	Personal nonagricultural income.
39.	TR	Government transfer payments.
40.	TPI	Personal income tax yield.
41.	TPY	Total yiled from personal income tax.
42.	TSS	Social security contributions.

B. Predetermined variables

i. Lagged endogenous :

1.	GA_{t-1}	Value added in agriculture, end of preceeding year.
2.	GM_{t-1}	Value added in manufacturing, end of preceding year.
3.	Y_{t-1}	Personal disposable income, preceding year.
4.	X_{t-1}	Exports, preceding year.

ii. Exogenous :

1.	L_{t-1}	Liquid assets, preceding year.
2.	GC	Government consumption expenditure.
3.	GI	Government investment expenditure.
4.	GΔST	Changes in stocks of public sector.
5.	ΣIM_{t-1}	Accumulated private fixed investment in manufacturing, end of preceding year.
6.	ΣIT_{t-1}	Accumulated private fixed investment in transportation, end of preceding year.
7.	GMN_{t-1}	Value added in mining, end of preceding year.
8.	ΣIMN_{t-1}	Accumulated private fixed investment in mining, end of preceding year.
9.	t	Time.
10.	TSD_{t-1}	Saving and time deposits, preceding year.
11.	P	Population, mid-year estimate.
12.	DAP7	Gross value of seven agricultural products.
13.	ΣTAP_{t-1}	Stock of agricultural products, end of preceding year.
14.	ΣTM_{t-1}	Stock of manufacturing produtcs, end of preceding yare.

15.	PAF	Relative price of imported animal and fishery products.
16.	PLA	Relative price of imported luxurious agricultural products.
17.	DCP_{t-1}	Domestic cereal production, end of preceding year.
18.	ΣTC_{t-1}	Stock of cereals, end of preceding year.
19.	$DOIL_{t-1}$	Domestic oil production, end of preceding year.
20.	$\Sigma TOIL_{t-1}$	Stock of oil, end preceding year.
21.	GW	Government wage bill.
22.	RXP	Greek export prices/World export prices.
23.	DGX	Value added, export oriented.
24.	TAI	Autonomous component of tax yields, personal income tax.
25.	TAPI	Autonomous component of tax yields, indirect taxes.

C. Variables exclusively utilized by equations (26) - (28)[8] *:*

1. XAF = Exports of animal and fishery products.
2. XA = Exports of agricultural products.
3. XT = Exports of tobacco.
4. XSL = Exports of hide skins and leather articles.
5. XF = Exports of forest products.
6. XMIN = Exports of mineral products.
7. XMET = Exports of metals and metal products.
8. XPG = Exports of pottery and glass.
9. XCP = Exports of chemical and pharmaceutical products.
10. XTXL = Exports of textile material articles.
11. XMISC = Exports of miscellaneous articles.
12. CON = Construction.
13. PE = Plant and equipment.

VII. A Discussion of the estimated Structure of the Model

In this section we intend to discuss the main points of the estimated structure of the econometric model; notably, to present specific differences between our work and [11], compare cur results to those obtained by Suits as well as [9] and [1], and emphazise important economic findings. The discussion will be carried on in terms of the subdivisions of section V.

A. Consumption Functions :

Equations (1) - (6) are disaggregated consumption functions of the private sector. They are expressed in terms of «disposable income», and «liquid assets» lagged one period [cf. 11]. Changes in either one of these variables are expected to influence private consumer expenditure in the same direction. Government consumption expenditures are treated as an exogenous variable.

Adding the six income coefficients, one can obtain the overall marginal propensity to consume (or mpc). This is equal to 0.728 and is in between the estimated mpc of 0.630 by Suits [11, p. 37], and 0.877 by Adelman and Chenery [1]. The fact that they both employed almost the same sample period (i.e., [11] used years 1951–61, and [1] 1950–61) and utilized 1954 constant prices implies that their results are biased. Suits' estimate is biased downwards, for he did not correct for autocorrelated residuals. That is, if we had not allowed for such a correction our estimated mpc would be equal to 0.700 [9]. On the other hand, the Adelman and Chenery coefficient is biased upwards for it relies on one explanatory variable, the disposable income.

Average partial income elasticities of various consumer demand categories were estimated and are given in Table 1 (cols. (1) and (2)). These estimates are reasonable and in line with existing economic theory. Thus, income elasticities associated with consumer expenditures for food, tobacco, and housing are positive but less than one; while those related to clothing, durable furniture, and other services exceed one.

TABLE 1

Income and Price Elasticities

Equation (1)	Income elasticity (2)	Equation (3)	Income elasticity (4)	Price elasticity (5)
1. CF	0.609	15. MMC'	1.487	
2. CT'	0.068	16. MMNC	3.153 *	
3. CC	1.260	17. MAF	1.154	—0.189
4. CH'	0.586	18. MLA	1.793	—0.629
5. CDF'	1.183			
6. COS	1.069			

* Based on an estimated mpm of nonconsumer manufactured goods of 0.280.

B. Investment and Stock Functions :

Equations (7) – (12) and (13) – (14) represent private fixed investment categories, and changes in inventories, respectively. As a rule, we used, after [11], two types of regressors in this analysis : that is, «the level of activity» in each sector lagged one period (herein to be referred to as «devel»); and «accumulated past investment» (eqs. (7) – (12)) [10], or «stocks of commodities» (eqs. (13) – (14)), both being referred to as «stocks», here. The nature of these variables indicates that Δ«devel»/ $\Delta dv > 0$, and Δ«stock»/$\Delta dv < 0$, where dv stands for the dependent variable.

Nevertheless, this general rule did not apply in the following equations. In (7), where the «stock» variable entered with a wrong sign and consequently was deleted from the equation in question. The «devel» variable was replaced by Y_{t-1} in (9), while the time trend was used in (11) because the proposed variables entered with wrong signs in that equation. Finally, past saving and time deposits, TSD_{t-1}, and population, were employed in (12). These variables entered with the expected positive signs.

Compared to the above, Suits adopted the following regressors in the corresponding equations : (a) Variables «devel» and the time trend in (7). The latter was used as a substitute for the «stock» variable [11, p. 63], but entered with a positive sign. We question the sign of this variable because of its very nature. (b) The «devel» variable in equation (8); (c) the time trend in (9); (d) variable TSD_{t-1} in (12). Lastly, equations (10), (11), (13), and (14) in our work and [11] rely upon the same regressors.

Investment expenditures, and changes in inventories in connection with the public sector are treated as exogenous variables.

C. Import and Export Functions :

Equations (15) and (16) relate to imports of consumer manufactured goods and nonconsumer manufactures, respectively. They are expressed in terms of «disposable income» (eq. 15), and «value added in manufacturing» (eq. 16). The choice of these explanatory variables rests upon the observed course of events. That is, on the one hand, we have the rather small size of domestic manufacturing industry, and consequently an inadequate supply of such goods produced domestically. On the other hand, rising incomes and living standards linked with a number of psychological factors create a very strong demand for electrical appliances, automobiles, etc. As a consequence of these tendencies, disposable income appears to be, and is a logical explanation of high import demand for consumer manufactures. This tendency, and the pressure for survival of Greek manufacturing in the light of economic integration of Greece with the European Economic Community (or E.E.C.) seem to explain the very high demand for nonconsumer manufactures. In other words, the only quick way to modernize obsolete equipment and methods of production, and be able to compete at home and abroad with known and established foreign products is through direct imports of ready-made (imported) capital goods [11]. These are expected to strengthen domestic production; promote exports; and help close the existing gap, in productivity terms, between Greece and economically advanced economies. Therefore, value added in manufacturing is a reasonable explanatory variable of equation (16).

Imports of agricultural products are subdivided into two categories : (a) without good domestic substitutes (eqs. (17) and (18)); and (b) with fairly good substitutes (eqs. (19) and (20)). The former utilize as regressors «disposable income», and their «relative import prices» ; the latter their «lagged domestic production», and their existing «stocks».

Adding the income coefficients of eqs. (15) – (18) we obtain the overall marginal propensity to import (or mpm.). Notice that, to compute the mpm of eq. (16), we require the implicit relationship between value added in manufacturing (see eq. (28)) and disposable income [11, p. 53]. The latter mpm is equal to 0.280. Consequently, the overall mpm is 0.510. This finding compares to the following estimates : 0.227 by Suits [11, p. 53]; 0.383 by Adelman and Chenery [1, p. 6] with GNP used as regressor; and 0.067 G.N.Y. [12] and 0.556R [13] by Pavlopoulos. The estimated mpm is consistent with governmental measures for free trade, i.e., to liberalize imports (1953), and economically associate the country with the E.E.C. (1961). Furthermore, it is a good example of a rapidly developing small economy heavily dependent on international trade.

Average partial income and price elasticities of import demand categories are presented in Table 1 (cols. (3) – (5)). All income elasticities exceed one and demostrate so to speak, the structural inadequacies of the Greek economic system. A simple comparison of income and price elasticities estimated for eqs. (17) and (18) reveals that this economy is more sensitive to changes in disposable income rather than changes in relative import prices (with respect to these groups of commodities).

Equation (21) characterizes an aggregate export function. It is written in terms of «exports» of commodities lagged one period», «relative export prices», and «domestic production of goods». Exports of commodities in year t are expected to respond in a positive way to last year's exports and domestic production. They are, however, inversely related to changes in relative prices.

D. Production and Income Functions:

These equations are subdivided into (a) seven identities necessary to close the model (eqs. (22) - (25), and (31) - (33) ; [14] (b) three aggregate production — value added — functions. (eqs. (26) - (28); (c) one depreciation equation, (29), expressed in terms of nonagricultural production after indirect taxes; and (d) one private wage bill function, (30), utilizing the same regressor as equation (29).

Wages paid by the public sector are treated as an exogenous variable. Equations cited under (a), (c), and (d) are in line with [11, pp. 79–82] and will not be commented on here. Nevertheless, eqs. (26) - (28) are essential because their dependent variables are — explicitly or implicitly — used as regressors in a number of equations, namely, (29) - (33) (37) - (40) and (42) [11, p. 74].

Thus, they should be discussed in more detail.

E. Estimation of the Coefficients of Production Functions:

Equations (26) - (28) are transformations of market demand into production categories. «The ideal tool for [such a] transformation... [is] a detailed input–output table for the Greek economy. But... [this table] is unavailable to us [Suits] at the oresent time [1963–64]. The estimates [Suits']... are based on the gross composition of individual productive activity and make no allowance for interindustry flows» [11, p. 74].

To improve upon [11] in connection with this shortcoming we take into account a recently published 50×50 input–output table of Greece for 1960 [6]. To this end, first consider the well–known equation.

(1) $Q=[I-A]^{-1}Z$

where Q is the 50×1 total industry output vector, each $q_1 \geq 0$; A is the 50×50 square matrix of constant input coefficients, each $a_{ij} \geq 0$; [I–A] is the technology matrix of the system ; and Z is the 50×1 final demand vector, each $z_1 \geq 0$. To obtain a nonnegative vector Q, the $[I-A]^{-1}$ must exist and be nonnegative. A necessary and sufficient condition, for the existence of such a solution is that all principal minors of the determinant [I - A] are strictly positive (Hawkins–Simon conditions) [15]. As a matter of fact, the determinant [I - A] pertaining to equation (1) has been estimated and is equal to 0.032369, and the product [I - A] $[(I-A)^{-1}] \simeq 1$ [16]. Since [11] disaggregates final demant into 20 categories, we can disaggregate the final demant vector Z into twenty 50×1 column vectors according to

$$(2)\ Z=[\,Z_{CF}+Z_{CT}+Z_{CC}+Z_{CH}+Z_{CDF}+Z_{COS}+Z_{GC}+ \\ +Z_{CON}+Z_{PE}+Z_{XAF}+Z_{XA}+Z_{XT}+Z_{XSL}+Z_{XF}+ \\ +Z_{XMIN}+Z_{XMET}+Z_{XPG}+Z_{XCP}+Z_{XTXL}+Z_{XMISC}\,],$$

thereby assigning the final demand for each of the fifty goods from

[6] to the twenty components of final demand. The meanings of all subscripts in (2) are provided in section VI.

By substituting equation (2) in (1) and solving for Q, we obtain the amounts or output that must be produced in order to satisfy various final demant vectors. But this is not all. Since imports participate in the production of various commodities — that are demanded — they should also be taken into account. Thus we multiply the 1×50 vector of import coefficients, per [6], by each of the twenty 50×1 vectors of final demand. This yields estimated amounts of imported goods necessary for the production of components of the specified final demand. The resulting figures are added vertically. Dividing column figures by column totals and aggregating over the industries we obtain the production components of final demand, given in Tables 2, 3 and 4. These coefficients appear in equations (26) - (28) of the model. For example, the first element of the last row Table 2 is equal to 0.558, to wit the coefficient of variable CF of eq. (26) ; coefficient $1-0.558=0.442$ corresponds to variable CF of eq. (27), etc. Certaintly these coefficients imply current prices. Thus, time series derived from eqs. (26) -(28) are expressed in current prices. Whenever thse series were required in constant 1958 prices they were transformed by means of implicit price deflators.

F. Institutional Equations :

Eight equations are presented here, to wit, equations (34) - (42). Two of them (eqs. (38) and (40)) are definitional. The remaining six exhibit certain worth reporting characteristics. On the one hand, they have some similarity with Suits' equivalent equations in the sense that they employ the same regressors. On the other hand, however, notable differences exist between the two sets of equations. That is, in equations corresponding to out (34), (41), and (42) Suits used the prevailing percentages of year 1961 (last year of his sample period). The others were O.L.S. regressions. In our estimation procedure, we forced all six equations through the origin (under the assumption that no tax yields are possible in absence of consumer expenditures and personal income) and applied the 2. S.L.S. method to each one of them.

But the new element in this analysis stems from a subdivision of total tax yields into two parts. First, the portion levied under normal circumstances from the regular funtioning of the economy (endogenous component). It, of course, assumes some existing tax structure. Second an autonomous component representing changes in government's tax policies in a particular year. Such changes may be related to tax rates and tax lebels. At this point various questions do arise. Should we disregard the previous legislation and exclusively concentrate on the new one? Or, shiuld we combine both in order to better represent the entire sample period? Answers to these questions, certainly, vary. For instance,

TABLE 2

Production Components of Consumer Demand

	Private Consumption						
Sector	Food (CF)	Tobacco (CT)	Clothing (CC)	Household Expenditure (CH)	Durable Furniture (CDF)	Other Services (COS)	Government Consumption (GC)
Agriculture	.442	.099	.057	.002	.033	.030	.054
Manufacturing	.399	.773	.743	.071	.719	.323	.282
Service	.136	.126	.168	.911	.135	.578	.617
Imports	.017		.028	.003	.085	.052	.035
Mining	.006	.002	.004	.013	.028	.017	.012
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Total Non-agriculture	.558	.901	.943	.998	.967	.970	.946

TABLE 3

Production Components of Fixed Investment

Sector	Construction (CON)	Plant & Equipment (PE)
Agriculture	.063	.190
Manufacturing	.784	.561
Services	.106	.068
Imports	.011	.179
Mining	.036	.002
Total	1.000	1.000
Total Non-agriculture	.937	.810

TABLE 4

Production Components of Exports

	Animal, Fishery Products (XAF)	Agricultural Products (XA)	Tobacco (XT)	Hide, Skins, Leather Products (XSL)	Forest Products (XF)	Mineral Products (XMIN)	Metals, Metal Products (XMET)	Pottery, Glass (XPG)	Chemical, Pharmaceutical (XCP)	Textile Material (XTXL)	Miscellaneous (XMISC)
Agriculture	.523	.358	.787	.281	.131	.444			.184	.027	.048
Manufacturing	.223	.491	.054	.519	.697	.146	.716	.666	.594	.811	.118
Services	.192	.128	.146	.156	.086	.234	.068	.235	.119	.135	.799
Imports	.054	.018		.041	.086	.160	.212	.037	.092	.027	.030
Mining	.008	.005	.003	.003		.016	.004	.062	.011		.005
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Total Non-agriculture	.477	.642	.213	.719	.869	.556	1.000	1.000	.816	.973	.952

Suits, claims that «with the change in tax law, the old data become obsolete and irrelevant, and should no longer be included in investigating the tax relationship. If the two sets of data are combined, the resulting relationship — however nicely it may appear to fit the tada — must be nonsense» [12, p. 117]. On the other hand, H. Theil recommends a combined respresentation of endogenous and exogenous components of tax yields [13, ch. 6]. The latter can be utilized by economic policy-makers as fiscal policy instruments. On the basis of the above, equations (38) and (40) attempt to incorporate both types of tax yields. Consequently, autonomous components of indirect taxes (or TAI) and personal income taxation (or TAPI) are included in these equations, respectively. The variables under consideration aim to estimate on a year-to-year basis portions of tax yields attributed to changes in government's taxation policy. With reference to Greece, such policies are not unusual (cf. [4]) and it is imperative that researchers should try to keep track of them. Variable TAI was derived as the horizontal sum of «taxes in favor of third parties», «special contributions on imported goods» and «consumption taxes on imported goods». Variable TAPI was estimated as the difference between observed yields from personal income taxation and the would be yields had the prior to 1954 conditions prevailed.