A DYNAMIC FIVE SECTOR MODEL FOR TURKEY, 1967 - 82*

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1. INTRODUCTION

This paper reports upon a dynamic extension of the macro model originally constructed as a consistency check upon the Second Five Year Plan of Turkey. We address ourselves to plan formulation - a task that is comparatively free of ideological elements. We do not attempt a diagnosis of the existing structure of the Turkish economy, nor of the factors leading to a 6.7 % real GNP growth rate from 1962-67, nor do we spell out the policy instruments (e.g. market incentives versus centralized controls) needed in order to propel the economy along the planned future trajectories.

Given the information base accumulated for the original consistency model, the dynamic extension turned out to be comparatively easy. No new data were collected, and only minor modifications were made in the technological norms. No more than a few man-months were needed in order to convert the original five-sector interindustry system into a dynamic one - a model which could in turn be used to identify the areas where it would be fruitful to disaggregate further, and to accumulate additional data. The ease of conversion is at least partially attributable to the formulation in terms of a "gradualist" consumption path. The gradualist path - together with certain additional hypotheses - permits us to adopt a short planning horizon for numerical computations (15 years), and yet to assert that the given plan would be not only feasible but also optimal if the planning horizon were extended over the infinite future. Aside from the objective function and terminal

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conditions, this model closely resembles those of Chakravarty and Lefeber (1965), Chenery and MacEwan (1966) and Eckaus and Parikh (1968) - focusing on a laborsurplus economy, one that is currently a recipient of net foreign aid, and one that must plan for trade-balance-improving activities so as to increase its future political independence.

The original Turkish macro model (for short the SPO model) was of the comparative statics type.* It analyzed the changes likely to take place between the terminal year of the First Plan (1967) and the terminal year of the Second Plan (1972). Investment outlays were treated endogenously as in Sandee (1960). That is, a stock-flow conversion factor was obtained for the five-year planning period by supposing that investment would rise linearly from its known value in the base year to an endogenously determined value in the target year. The SPO model was not of an optimizing type. In order to calculate the requirements for external assistance, the rate of import substitution - as well as of export promotion - was specified exogenously for the target year.

The present calculations differ from the orginal SPO model in that we specify upper bounds on external assistance, and derive the requirements for trade-balance-improving activities through explicit optimization. Moreover, this is a dynamic model - one in which each period's investment outlays depend upon increases in future capacity requirements, not upon extrapolations from past output increases. The objective function is stated as one of maximum consumption, subject to the constraints imposed by a gradualist path and the specific numerical value adopted for the asymptotic growth rate. No bound is placed upon the domestic marginal propensity to save, except in the one case where a "classical" savings function is postulated.

As in the original SPO model, the following five-sector interindustry classification is employed here :

1. agriculture
2. mining

* The original model (as presented to an international colloquium in 1966) is described in a mimeographed paper available upon request to the Turkish State Planning Organization.

3. manufacturing
4. construction
5. services

Our model covers a span of 15 years, terminating in 1982 (the currently planned date for Turkey's entrance into full membership in the European Common Market). Sectoral balances are computed for the following representative periods - each a single year in length- and each spaced at intervals of 2.5 years :

Representative Year	Time Period Index t
1967	0
1969 - 70 (average)	1
1972	2
1974 - 75 (average)	3
1977	4
1979 - 80 (average)	5
1982	6

2 THE MAXIMAND - GRADUALIST CONSUMPTION FATHS

By restricting comsumption paths to those of a gradualist pattern, we obtain a multi-sector formulation that is numerically computable, and yet which retains something of the spirit of the Ramsey (1928) optimal savings model. The intertemporal choice is posed as one between comsumption increases in the near future versus those in the distant future. Unlike the Ramsey formulation, it is required that all admissible consumption paths branch off from the known initial value C_0. Moreover, asymptotically over time, it is required that consumption grow at the rate g. In general, the higher the value taken for the subjective policy parameter g, the more investment-oriented becomes the optimal development plan, and the lower the near-term rate of growth of consumption.

Let C_t denote aggregate consumption expenditures at date t. The quantity C_0 is a datum, the rate of actual consumption during the base year 1967. For subsequent years, the quantity C_t is evaluated simultaneously with the other unknowns of the programming model. Letting g denote the asymptotic growth rate (a subjective policy parameter), and letting D denote the initial consumption increment (a linear programming unknown), the formal definition of a gradualist path is as follows :

$$C_t = C_0 + D \left[\frac{(1+g)^t - 1}{g} \right], \quad (t = 0, 1, 2, \ldots, +\infty) \tag{1}$$

It follows that :

$$D = C_1 - C_0 \text{ , and}$$

$$g = \lim_{t \to +\infty} \left[\frac{C_{t+1} - C_t}{C_t} \right]$$

With $g > \frac{D}{C_0} > 0$, note that $(C_{t+1} - C_t)/C_t$ (the percentage rate of growth of consumption) rises smoothly over time, asymptotically approaching g. The linear programming maximand is taken to be $D = C_1 - C_0$. Since the comsumption increments in all other time periods are proportional to D, it follows that consumption is being maximized *at all points* of time - subject to the restriction imposed by equation (1) and to he fixed values assigned to C_0 and g. For our basic numerical calculations, we have set g=8 %, a quantity slightly higher than the 7 % annual GNP growth rate target adopted officially for the Second Five Year Plan.

The intertemporal tradeoff is summarized in terms of the two parameters g and D. The higher the value of g, the lower that of D. Caution: It cannot be expected that two such parameters will be sufficient to characterize the development paths of all economies. All that is being proposed is an approximation that may prove useful during a labor-surplus development phase. For a mature economy, a more acceptable idealization would be that the asymptotic growth rate is governed by the growth of the labor force as measured in Harrod-neutral efficiency units. See e.g. Solow, Tobin, von Weizacker, and Yaari (1966).

3. ADDITIONAL BASIC ASSUMPTIONS

For want of a detailed analysis of Turkey's agricultural sector, the output of that sector (together with the consumption and exports of agricultural products) is assumed to grow at a fixed exogenous rate, 4.26 % per annum (the equivalent of 11 % compounded over 2.5 years). The flow of interindustry deliveries on current and capital account is assumed to be one-directional - from the other sectors into agriculture. In this way, we allow for an acceleration in deliveries of non-traditional inputs (e.g. fertilizers and tractors) into agriculture - without supposing that agricultural inputs into industry (e.g. raw cotton) will grow as rapidly as manufacturing output itself.

For consistency with the assumption with respect to agriculture, the quantity C_t is defined as aggregate *non*-agricultural consumption expenditures during year *t*. Increments in non-agricultural consumption are to be delivered from the non-agricultural sectors in predetermined proportions: 1 % from mining, 49 % from manufacturing, and 50 % from services. The asymptotic growth rate, together with the predetermined proportions for consumption increments, determines the parameters d_{it}, the increment in consumption demand for item *i* between period *0* and *t*, per unit of the maximand *D*. For further details, see Table A. 4 below.

As of the base year (1967), the bulk of Turkey's merchandise exports originated in the agriculture and mining sectors. Export earnings from these traditional items, together with invisibles (principally tourism and workers' remittances) are projected exogenously throughout our planning horizon. See Table A. 5.

In 1967, virtually all of Turkey's merchandise imports consisted of manufactured products (sector 3). This is the sector in which there appears to be maximum scope for both import substitution and export promotion. Our investment planning model derives the requirements for trade-balance-improving activities by treating as an endogenous unknown y_{3t}, the imports less exports of manufactures during period *t*. It would require considerable disaggregation within the manufacturing sector before one could hope to draw reliable conclusions on comparative advantage - which specific items to export and which to import. For work along these lines, see Weisskopf (1967) and Bruno, Fraenkel and Dougherty (1968).

Re initial conditions: For the base year 1967, it is assumed that all quantities (output, interindustry demands, consumption, etc.) are known except for the sectoral distribution of investment outlays. See Table A.1. Subject only to the constraint that aggregate investment not exceed the known value of 17.58 billion TL* during 1967 (period 0), we have supposed that the distribution by sector of destination is completely flexible. In turn, these investment outlays determine the capacity increments first available during period 1. With this formulation, we err on the side of flexibility in the sectoral distribution of the initial increments in output.

Re terminal conditions : For the terminal year 1982 (period 6), it is supposed that the new capacity created will be in "turnpike" proportions, permitting subsequent investment growth to be maintained at the annual geometric rate g (= 8.0% for our basic case) in all sectors over the indefinite future. Although our formulation implies that asymptotically, all sectoral capacities will grow at the identical rate g, it does *not* imply identical output growth rates in all sectors during the immediate post-terminal years.

4 ALGEBRAIC FORMULATION

In this linear programming model, nonnegative values are to be assigned to 91 unknowns, defined as follows :

		Definitions	Number of Unknowns
D	=	increase in non-agricultural consumption between period 0 and period 1 = maximand	1
X_{jt}	=	output increment in sector j between initial year and period t ($j = 1, \ldots, 5$) ($t = 1, \ldots, 6$)	30
Δ_{jt}	=	annual increment in capacity of sector j during 2.5 years centered around period t. ($j = 1, \ldots, 5$; $t = 0, 1, \ldots, 6$)	35
Y_{3t}	=	annual imports less exports of manufactures during period t. ($t = 1, \ldots, 6$)	6
I_t	=	annual gross investment during period t ($t = 0, 1, \ldots, 6$)	7
S_t	=	annual domestic savings during period t ($t = 1, \ldots, 6$)	6
F_t	=	annual foreign loan inflow during period t ($t = 1, \ldots, 6$)	6
			91

* All numerical magnitudes refer to 1965 prices. At these prices : 1 billion TL = 1 billion Turkish lira = U.S. $ 111 millions.

There are 91 equality and inequality constraints :

Identification of Constraint	Purpose	Number of Constraints
A	material balances	30
B	capacity constraints	30
C	terminal constraints on investment	5
D	definition of gross investment	7
E	relation between domestic savings, investment, and foreign loans	7
F	foreign exchange balance	6
G	upper bound on foreign loans	6
	Total	91

Material balances : Let a_{ij} denote the current account input (if negative) or output (if positive) from sector i associated with a one unit gross output increase in sector j. Let b_{ij} denote the capital input requirement from sector i associated with a one unit increase in the gross annual output capacity of sector j. Let d_{it} denote the increase in consumption demand between time O and t for sector i per unit of the unknown D. Then :

$$\text{(A)}\quad \begin{bmatrix}\text{year 0}\\ \text{output}\\ \text{net of}\\ \text{interindustry}\\ \text{demand}\end{bmatrix} + \begin{bmatrix}\text{increase}\\ \text{above}\\ \text{year 0}\\ \text{output,}\\ \text{net of}\\ \text{interindustry}\\ \text{demand}\\[6pt] \displaystyle\sum_{j=1}^{5} a_{ij} X_{jt}\end{bmatrix} + \begin{bmatrix}\text{net}\\ \text{imports}\\ (i=3)\\[6pt] Y_{it}\end{bmatrix} \geqslant \begin{bmatrix}\text{exogenous}\\ \text{consumption}\\ \text{demand}\end{bmatrix} +$$

$$\begin{bmatrix}\text{endogenous}\\ \text{consumption}\\ \text{demand}\\ (i=2,3,5)\\[6pt] d_{it}\,D\end{bmatrix} + \begin{bmatrix}\text{endogenous}\\ \text{investment}\\ \text{demand}\\[6pt] \displaystyle\sum_{j=1}^{5} b_{ij}\,\Delta_{jt}\end{bmatrix} + \begin{bmatrix}\text{exogenous}\\ \text{investment}\\ \text{demand by}\\ \text{power and}\\ \text{transportation}\end{bmatrix} + \begin{bmatrix}\text{exogenous}\\ \text{net exports}\\ (i \neq 3)\end{bmatrix}$$

$(i = 1, \ldots, 5;\ t = 1, \ldots, 6)$

Capacity constaints :

(B)

$$2.5 \begin{bmatrix} \text{Sum of annual capacity} \\ \text{increments between} \\ \text{period 0 and t} \end{bmatrix} \geqslant \begin{bmatrix} \text{Output increment} \\ \text{between period} \\ 0 \text{ and } t+1 \end{bmatrix}$$

$$2.5 \left[\sum_{\tau=0}^{t} \Delta_{j\tau} \right] \geqslant X_{j,t+1}$$

$(j = 1, \ldots, 5; \quad t = 0, 1, \ldots, 5)$

Constraints (B) are written as though time were continuous; the requirement for investment resources, Δ_{jt}, remains constant for the 2.5 year interval centered around about instant t itself; and there is a lag of 1.25 years between the resource input and the availability of capacity from that input. Figure 1 illustrates how this lag process is assumed to operate.

Terminal constraints on investment : These constraints refer to the *change* in the material balance constraints between period 6 and 7. Note that each of the left-hand side unknowns bears the time subscript 6 :

(C)

$$\sum_{j=1}^{5} \left[2.5\, a_{ij} - ((1+g)^{2.5} - 1)\, b_{ij}\right] \Delta_{j6} \geqslant$$

$$(d_{i7} - d_{i6})\, D + \begin{bmatrix} \text{exogen-} \\ \text{ous con-} \\ \text{sumption} \\ \text{demand,} \\ \text{period 7} \end{bmatrix} - \begin{bmatrix} \text{exogen-} \\ \text{ous con-} \\ \text{sumption} \\ \text{demand,} \\ \text{period 6} \end{bmatrix} + \begin{bmatrix} \text{exogen-} \\ \text{ous in-} \\ \text{vestment} \\ \text{demand,} \\ \text{period 7} \end{bmatrix} - \begin{bmatrix} \text{exogen-} \\ \text{ous in-} \\ \text{vestment} \\ \text{demand,} \\ \text{period 6} \end{bmatrix}$$

$(i = 1, \ldots, 5)$

For $t = 6, 7, \ldots, +\infty$, let :

(2) $\Delta_{j,t+1} = (1+g)^{2.5}\, \Delta_{jt}$, and

(3) $X_{j,t+1} = 2.5\, \Delta_{jt} + X_{jt}$

If we suppose that the increments in consumption and exogenous investment grow at the annual rate g, and if we neglect the terms referring to import and export increases, the terminal investment constraints (C), together with the primal solution (2) and (3) ensure that all material balance and capacity constraints will be satisfied over the infinite future following period 6.* Proof : For a period $t > 6$, multiply constraint (C) for item i by $(1+g)^{2.5(t-7)}$ and add to the corresponding material balance constraint (A) for item i, period 6. That the capacity constraints are also satisfied over an infinite horizon follows directly from (3) and the fact that constraints (B) are satisfied for period 6. This concludes the proof of primal feasibility for an infinite time horizon.**

Definition of gross investment :

$$\text{gross investment} = \begin{bmatrix} \text{aggregate} \\ \text{capital -} \\ \text{output} \\ \text{ratio,} \\ \text{sector } j \end{bmatrix} \begin{bmatrix} \text{one year} \\ \text{production} \\ \text{increment} \end{bmatrix} + \begin{bmatrix} \text{gross exogen-} \\ \text{ous investment} \\ \text{demand by} \\ \text{power and} \\ \text{transportation} \end{bmatrix}$$

(D)

$$I_t = \sum_{j=1}^{5} k_j \qquad \Delta_{jt} \qquad + \quad [\quad]$$

$$(t = 0, 1, \ldots, 6)$$

Relation between domestic savings, investment and foreign loans:

Gross investment is predetermined at 17.58 TL billions during the initial year, and is endogenously determined during subsequent years :

(E)
$$I_0 = 17.58$$
$$I_t = S_t + F_t \qquad (t = 1, \ldots, 6)$$

* Construction (2) and (3) implies that agriculture will have the same asymptotic growth rate as the other sectors. This slightly overstates the terminal investment requirements in agriculture, but enables us to avoid an additional set of terminal investment constraints.

** Note that this proof does not imply that the particular solution is *optimal*. For a statement of sufficient conditions to ensure optimality over an infinite planning horizon, see Manne (1970) and Hopkins (1969). These proofs hinge upon certain additional hypotheses concerning the optimal solution during the terminal periods of the finite horizon planning model: positive output and investment levels in all sectors, no slack capacites, and no excess production. Fortunately, these additional hypotheses are satisfied by the solutions recorded here, and so these solutions have the property of infinite horizon optimality. Moreover, a "Leontief trajectory" (one with no slack and with positive output and investment in all sectors) is feasible during all post-terminal periods.

Foreign exchange balance :

(F)

$$\text{foreign loan requirement} = \begin{bmatrix}\text{merchandise} \\ \text{imports,} \\ \text{less exports} \\ \text{of manufactures} \\ \text{(sector 3)}\end{bmatrix} - \begin{bmatrix}\text{merchandise} \\ \text{exports,} \\ \text{less imports} \\ \text{of non} \\ \text{manufactures} \\ \text{(see Table A. 5)}\end{bmatrix} - \begin{bmatrix}\text{net} \\ \text{exports} \\ \text{of} \\ \text{invisibles} \\ \text{(see Table} \\ \text{A. 5)}\end{bmatrix}$$

$$F_t = Y_{3t} - [\ \ ] - [\ \ ]$$

$$(t = 1, \ldots, 6)$$

Upper bound on foreign loans :

(G) $F_t \leqslant \overline{F}_t$, upper bound, year t

$(t = 1, \ldots, 6)$

6 NUMERICAL DATA

The numerical data were drawn from the latest available work sheets at the Turkish State Planning Organization, and supplemented by our own informal estimates. *Further work is needed to improve the reliability of these estimates.* The data are organized into appendix tables as follows :

Table A.1	1967 flows and sectoral identification
Table A.2	Technological norms
Table A.3	Derivation of consumption demand
Table A.4	Derivation of d_{it}
Table A.5	Exports and invisibles
Table A.6	Sectoral distribution of exogenous investment
Table A.7	Derivation of right-hand side constants : material balance constraints (A)
Table A.8	Derivation of right-hand side constants : terminal investment constraints (C)
Table A.9	Derivation of righ-hand side constants : foreign exchange balance (F)

The linear programming computations were performed on the IBM 360/67 at Stanford University. The time required for a single solution never exceeded one minute.

7. NUMERICAL RESULTS

Our five-sector model implies that the growth of the Turkish economy will not be constrained by the growth of the labor force nor by labor productivity. Rather, we focus upon foreign exchange and capital accumulation constraints - as expressesed in terms of two macroeconomic parameters : the asymptotic growth rate g, and the upper bound on foreign loan inflows. For the basic numerical results (Table 1), it is supposed that $g = 8\,\%$; that the limit on foreign loans will be 2.0 billion TL (1965 prices) during periods 1, 2, and 3; that this limit will diminish to 1.0 billion during period 4; and that self-reliance will commence at period 5 and continue thereafter. Subject to the gradualist path restriction, consumption is to be maximized at all points of time.

From Table 1, it can be seen that these macroeconomic parameters imply growth rates slightly below those of the officially stated targets for the Second Five Year Plan: 7% for GNP and 12% for manufacturing output. A closer approximation to the Second Plan targets is obtained if the value of g is raised to 10%. (See Table 2.) Along with this increase in g, note the corresponding increase in requirements for fiscal austerity - as measured by the marginal propensity to save. Figure 2 provides a visual comparison of the tradeoff between consumption increases in the near versus distant future. With $g = 10\%$ rather than 8%, there would be a comparatively minor difference during the first three time periods. By period 4 (1977), however, the more austere policy would begin to yield additional consumption, and would provide an increasing advantage thereafter.

In Table 3, we maintain the asymptotic growth rate at 8 %, and explore the implications of a substantial reduction in rcliance upon foreign loans. Note the direct economic consequences of this move toward political independence - a lowering of consumption targets during the Second Plan, an increase in the marginal savings ratio, and hence an increase in domestic austerity. Perhaps less obvious is the indirect effect - an increase in the Second Plan targets for manufacturing output, i.e. an increase in the requirements for trade-balance-improving activities.

Year *t*	1967 0	1	1972 2	3	1977 4	5	1982 6
1. output of agriculture	38.80	42.51	47.37	52.75	58.69	65.24	72.35
2. " " mining	2.20	2.98	3.90	5.03	6.39	8.03	9.96
3. " " manufacturing	48.67	60.77	75.83	94.09	116.77	143.44	174.70
4. " " construction	8.62	10.74	12.98	15.76	18.76	22.37	26.14
5. " " services	53.53	60.73	69.77	80.25	92.98	108.20	126.50
Y_{3t}, imports less exports of manufactures	5.40	7.33	8.30	9.00	8.87	8.80	9.95
1. investment in agriculture	2.08	2.72	3.01	3.33	3.67	3.98	3.91
2. " " mining	.57	.68	.83	1.00	1.21	1.42	1.63
3. " " manufacturing	5.81	7.23	8.76	10.89	12.80	15.01	18.73
4. " " construction	.76	.81	1.00	1.08	1.30	1.36	1.92
5. " " services	4.90	6.15	7.12	8.66	10.35	12.44	14.50
Exogenous investment	3.46	5.05	7.00	8.75	10.80	13.30	15.90
I. Gross investment	17.58	22.63	27.74	33.70	40.12	47.51	56.59
F, Foreign loans	1.12	2.00	2.00	2.00	1.00	0.00	0.00
S, Domestic savings	16.46	20.63	25.74	31.70	39.12	47.51	56.59
TC, Total consumption	68.92	79.71	92.64	108.05	126.56	148.69	175.26
$GNP = TC + S$	85.38	100.34	118.37	139.76	165.68	196.19	231.84
Agricultural consumption	16.50	18.31	20.33	22.57	25.05	27.80	30.86
C, non-agricultural consumption	52.42	61.40	72.31	85.48	101.51	120.89	144.40
% / year growth of *I*		10.63	8.48	8.10	7.22	7.00	7.25
% / year growth of *C*		6.53	6.76	6.92	7.12	7.24	7.37
% / year growth of *TC*		5.99	6.20	6.35	6.53	6.66	6.80
% / year growth of *GNP*		6.67	6.83	6.87	7.04	6.99	6.91
Propensity to save (average for year 0: marginal thereafter)	.193	.279	.283	.279	.286	.275	.255
Incremental capital-output ratio		2.94	3.14	3.24	3.25	3.29	3.33

TABLE 2. HIGHER ASYMTOTIC GROWTH (Units : TL. billions, 1965 prices) $g =$ asymptotic growth rate of $C = 10\,\%$

Year t	1967 0	 1	1972 2	 3	1977 4	 5	1982 6
1. output of agriculture	38.80	42.51	47.37	52.75	58.69	65.25	72.38
2. " " mining	2.20	2.98	3.94	5.16	6.72	8.64	11.00
3. " " manufacturing	48.67	61.04	76.90	97.00	122.77	154.58	193.73
4. " " construction	8.62	10.87	13.45	16.76	20.57	25.25	30.64
5. " " services	53.53	60.47	69.57	80.49	94.33	111.64	133.35
Y_{3t}, imports less exports of manufactures	5.40	7.33	8.30	9.00	8.87	8.80	9.95
1. investment in agriculture	2.08	2.72	3.01	3.33	3.67	3.99	3.97
2. " " mining	.57	.71	.89	1.15	1.41	1.74	2.09
3. " " manufacturing	5.94	7.61	9.65	12.37	15.27	18.79	24.39
4. " " construction	.81	.93	1.19	1.37	1.69	1.94	2.74
5. " " services	4.72	6.19	7.42	9.41	11.77	14.76	18.17
Exogenous Investment	3.46	5.05	7.00	8.75	10.80	13.30	15.90
I, Gross investment	17.58	23.21	29.17	36.38	44.61	54.53	67.25
F, Foreign loans	1.12	2.00	2.00	2.00	1.00	0.00	0.00
S, Domestic Savings	16.46	21.21	27.17	34.38	43.61	54.53	67.25
TC, Total consumption	68.92	79.22	92.04	107.94	127.78	152.56	183.56
$GNP = TC + S$	85.38	100.43	119.20	142.33	171.39	207.09	250.81
Agricultural consumption	16.50	18.31	20.33	22.57	25.05	27.80	30.86
C, non - agricultural consumption	52.42	60.91	71.71	85.37	102.73	124.76	152.70
% / year growth of I		11.75	9.57	9.24	8.50	8.36	8.75
% / year growth of *C*		6.19	6.75	7.22	7.69	8.08	8.42
% / year growth of *TC*		5.73	6.18	6.58	6.98	7.35	7.68
% / year growth of *GNP*		6.71	7.09	7.35	7.71	7.86	7.96
Propensity to save (average for year O; marginal thereafter)	.193	.316	.318	.312	.318	.306	.291
Incremental ca ital-out ut ratio		2.92	[illegible]	3.15	3.13	[illegible]	3.12

TABLE 3. LOWER FOREIGN LOAN INFLOW (Units : TL billions, [illegible] prices; g = asymptotic growth rate of [illegible] %)

Year t	1967 0	1	1972 2	3	1977 4	5	1982 6
1. output of agriculture	38.80	42.51	47.37	52.75	58.69	65.24	72.35
2. " " mining	2.20	2.98	3.90	5.00	6.30	7.87	9.74
3. " " manufacturing	48.67	61.10	76.22	94.17	115.52	140.56	170.95
4. " " construction	8.62	10.62	12.77	15.37	18.30	21.96	25.65
5. " " services	53.53	60.56	69.38	79.56	91.88	106.62	124.39
Y_{3t}, imports less exports of manufactures	5.40	6.83	7.30	7.50	7.87	8.80	9.95
1. investment in agriculture	2.08	2.72	3.01	3.33	3.67	3.98	3.91
2. " " mining	.57	.68	.82	.95	1.16	1.38	1.58
3. " " manufacturing	5.96	7.26	8.62	10.25	12.02	14.59	18.22
4. " " construction	.72	.77	.94	1.05	1.32	1.33	1.88
5. " " services	4.78	6.00	6.92	8.38	10.02	12.08	14.06
Exogenous investment	3.46	5.05	7.00	8.75	10.80	13.30	15.90
I, Gross investment	17.58	22.48	27.30	32.71	38.99	46.66	55.56
F, Foreign loans	1.12	1.50	1.00	0.50	0.00	0.00	0.00
S, Domestic Savings	16.46	20.98	26.30	32.21	38.99	46.66	55.56
TC, Total consumption	68.92	79.42	92.00	106.99	124.98	146.49	172.31
$GNP = TC + S$	85.38	100.40	118.30	139.21	163.97	193.15	227.87
Agricultural consumption	16.50	18.31	20.33	22.57	25.05	27.08	30.86
C, non - agricultural consumption	52.42	61.11	71.67	84.42	99.93	118.69	141.45
% / year growth of *I*		10.33	8.08	7.50	7.28	7.45	7.23
% / year growth of *C*		6.33	6.58	6.77	6.98	7.12	7.27
% / year growth of *TC*		5.84	6.06	6.22	6.41	6.56	6.71
% / year growth of *GNP*		6.70	6.78	6.73	6.77	6.77	6.71
Propensity to save (average for year 0; marginal thereafter)	.193	.301	.297	.283	.274	.263	.256
Incremental capital - output ratio		2.93	3.14	3.26	3.30	3.34	3.36

TABLE 4

Basic Case. Dual Variables (multiplied by 10^2)
Primal solutions shown in Tables 1 and 3.

Constraints \ Year t	1967 0	1	1972 2	3	1977 4	5	1982 6
$A1_t$		13.717	7.080	3.305	1.490	.663	.526
$A2_t$		10.881	4.782	2.110	.931	.410	.324
$A3_t$		8.236	3.634	1.603	.707	.312	.246
$A4_t$		8.356	3.680	1.623	.716	.316	.249
$A5_t$		11.236	5.018	2.209	.974	.430	.339
$B1_t$	13.085	7.071	3.352	1.520	.678	.538	
$B2_t$	19.338	8.468	3.738	1.648	.727	.574	
$B3_t$	12.577	5.544	2.445	1.078	.426	.375	
$B4_t$	9.459	4.142	1.828	.806	.356	.281	
$B5_t$	17.694	7.931	3.490	1.539	.679	.536	
$C1$							.499
$C2$							.307
$C3$							.233
$C4$							.236
$C5$							.321
D_t	18.746	0.00	0.00	0.00	0.00	0.00	0.00
E_t	18.746	0.00	0.00	0.00	0.00	0.00	0.00
F_t		8.236	3.634	1.603	.707	.312	.246
G_t		8.236	3.634	1.603	.707	.312	.246

(Units : TL. billions,

Year t	1967 0	1
1. output of agriculture	38.80	42.11
2. " " mining	2.20	2.70
3. " " manufacturing	48.67	56.12
4. " " construction	8.62	8.62
5. " " services	53.53	59.41
Y_{3t}, imports less exports of manufactures	5.40	7.33
1. investment in agriculture	3.11	1.69
2. " " mining	.37	.70
3. " " manufacturing	4.66	6.27
4. " " construction	.78	.42
5. " " services	5.20	4.59
Exogenous Investment	3.46	5.05
I, Gross investment	17.58	18.73
F, Foreign loans	1.12	2.00
S, Domestic Savings	16.46	16.73
TC, Total consumption	68.92	78.53
$GNP = TC + S$	85.38	95.26
Agricultural consumption	16.50	18.31
C, non - agricultural consumption	52.42	60.22
% / year growth of *I*		2.57
% / year growth of C		5.71
% / year growth of *TC*		5.36
% / year growth of *GNP*		4.48
Propensity to save (average for year O; marginal thereafter)	.193	.027
Incremental capital - output ratio		4.45

1965 prices) g = asymptotic growth rate of $C = 8\,\%$

1972 2	3	1977 4	5	1982 6
47.37	52.75	58.69	65.24	72.35
3.65	4.67	5.89	7.37	9.09
71.45	87.73	107.99	131.72	159.42
11.96	14.63	17.40	20.71	24.13
67.77	77.04	88.30	101.74	117.88
8.30	9.00	8.87	8.80	9.95
3.01	3.33	3.67	3.98	3.91
.75	.90	1.09	1.27	1.44
7.82	9.72	11.39	13.30	16.66
.96	1.00	1.10	1.23	1.76
6.19	7.66	9.14	10.98	12.72
7.00	8.75	10.80	13.30	15.90
25.74	31.35	37.28	44.05	52.40
2.00	2.00	1.00	0.00	0.00
23.74	29.35	36.28	44.05	52.40
90.04	103.73	120.14	139.73	163.23
113.77	133.08	156.41	183.79	215.63
20.33	22.57	25.05	27.80	30.86
69.71	81.16	95.09	111.93	132.37
13.56	8.21	7.18	6.90	7.19
6.03	6.27	6.54	6.74	6.94
5.62	5.82	6.05	6.23	6.42
7.36	6.47	6.67	6.67	6.60
.379	.291	.297	.284	.262
2.53	3.33	3.36	3.40	3.46

In order to measure the marginal productivity of foreign loans, compare Tables 1 and 3, and note that an annual difference of approximately 1.0 billion TL - maintained over the decade ending in 1977 - would imply a difference of 4.0 billion TL in Turkey's 1982 GNP, and a growing difference thereafter. Another indication of the productivity of foreign loans is the sequence of shadow prices associated with the upper bound constraints on loan inflows. The fact that these values drop sharply over time is a reflection of the dictum "more aid to end aid sooner". Moreover, this time series indicates that it would *not* be optimal to carry over aid from one time period to the next. Since there was no change in the optimal "basis" for the conditions of Tables 1 and 3, the shadow prices of Table 4 are identical for both sets of macroeconomic parameters.

The results of one further experiment are reported in Table 5 - the effect of imposing a seemingly more realistic set of initial conditions. Instead of requiring only that the sectoral investment allocations add up to a predetermined total (see constraint (E) for period O), a further condition is imposed - that the investment allocation to each of the five sectors must match up with its known value during this initial period. With the additional constraints upon investment allocations, it turns out that there is a sharp drop in the growth of consumption and of GNP. These macroeconomic effects can be traced to the existence of excess capacity in the agritural sector during period 1, together with the specification that agricultural output, consumption and exports are exogenously determined. From this experiment, we infer that it is undesirable to include a more rigid set of initial conditions without also including a more flexible set of alternatives for capacity utilization during the initial time periods. It is because of these offsetting considerations that in all other experiments reported here, we have employed the single aggregative investment equation (EO), rather than individual constraints upon the sectoral composition of investment.

8. IMPLICATIONS OF A "CLASSICAL" SAVING FUNCTION

Given a focus upon physical capital formation (ignoring labor constraints, education, nutrition and human capital formation), it should come as no surprise that the marginal productivity of capital is of the same order of magnitude as the economy-wide output-capital ratio, 30% per year. This is a point that has previously been emphasized by Harberger (1967, pp. 141 - 142) in his critique of project evaluation based upon a zero shadow price for labor. Moreover, it is a point that leads to the suspicion that Tables 1 and 3 overstate the "leverage" effects of physical capital and of foreign loans.

As an alternative formulation - one which imputes a non-zero wage to labor, and correspondingly less leverage to physical capital - it is instructive to examine the "classical" savings assumption. (See, e.g. Hahn and Matthews (1965), pp. 23-26.) Labor is regarded, in effect, as another commodity produced with the aid of commodities. For a labor-surplus economy such as Turkey, this classical assumption is not as unreasonable as it would be in the case of a mature economy such as the U.S.A. Here we have not attempted to go beyond regarding labor as a current account input. An obvious extension of this numerical planning model for the Turkish economy (one upon which we hope to report at some future date) is to include human capital formation activities - the effects of education and of childhood nutrition intake.

With a "classical" savings viewpoint, it is assumed that the central planning authority does not possess sufficiently potent instruments (e.g. via fiscal policy, inflation or rationing) to exert direct control over the time path of workers' consumption. Rather, it is supposed that any increments in output lead to proportionate increments in wage income - and in workers' demands for consumption goods. Thus, a steel mill laborer's demand for cotton textiles is viewed as a current input of cotton textiles into the process of steel production - just as an input of coke, iron ore or limestone.

According to the classical view, it is only with respect to non-wage income that there exists the possibility of a tradeoff between consumption increments in the near and the distant future. These consumption increments out of non-wage income are to grow at the constant geometric rate g - a rate which is an arbitrarily specified policy parameter, as before. Letting the constant w_j denote the marginal wage income per unit of output in sector j, and letting the maximand D now represent the first period's increase in non-wage consumption, the gradualist time path (1) is therefore rewritten as follows :

$$(1') \qquad C_t = C_0 + \sum_{j=1}^{5} w_j X_{jt} + D \left[\frac{(1+g)^t - 1}{g} \right]$$

$$(t = 0, 1, 2, \ldots . . + \infty)$$

Let c_i denote the increment in demand for item i per unit increment in wage income.* Then, in the material balance constraints (A) and the terminal investment constraints (C), the original input-output coefficients a_{ij} are modified to new values a'_{ij} , allowing for wage-generated consumption demands as follows :

$$a'_{ij} = a_{ij} - c_i w_j$$

For purposes of illustrating the classical savings model - and in the absence of any carefully collected data on wage and profit shares in Turkey - we have made a heroic assumption, and taken the gross rate of return on capital (including depreciation and taxes) as a uniform amount, 20% per year in all sectors, and let wages constitute the residual element in value added.** That is, the wage coefficients w_j shown in Table A. 2 were estimated residually as :

$$w_j = \sum_{i=1}^{5} a_{ij} - .20\, k_j$$

Using the same numerical parameters as the basic case – but but with the classical savings function – we obtain the results shown in Table 6. (The linear program consists of maximizing D, subject to (1′) and to constraints (A) – (G), modifying the coefficients a_{ij} to a'_{ij} in order to allow for labor inputs, a non-zero wage and a classical savings function.) The orders of magnitude of the primal vari-

* The numerical values of these marginal consumption coefficients are identical to those employed for computing d_{it} in Table A. 4. Note the unfortunate consequence - no allowance for additional spending on agricultural products out of wage income. Because of the initial assumption that agriculture is to grow at a predetermined rate, we must continue to regard the quantity C_t as aggregate consumption expenditures on non - agricultural items.

** We have also experimented with a 15 % gross rate of return. Keeping all numerical parameters identical with those of the basic case (Table 1), it turns out that there is then no feasible programming solution !

(Units : TL. billions, 1965 prices) g = asymptotic growth rate of C — 8 %

Year t	1967 0	1	1972 2	3	1977 4	5	1982 6
1. output of agriculture	38.80	42.51	47.37	52.75	58.69	65.24	72.35
2. " " mining	2.20	2.97	3.89	5.00	6.33	7.89	9.70
3. " " manufacturing	48.67	60.70	75.61	93.45	115.32	140.72	170.07
4. " " construction	8.62	10.75	12.88	15.53	18.23	21.41	25.19
5. " " services	53.53	60.78	69.88	80.26	92.77	107.31	124.34
Y_{3t}, imports less exports of manufactures	5.40	7.33	8.30	9.00	8.87	8.80	9.95
1. investment in agriculture	2.08	2.72	3.01	3.33	3.67	3.98	3.91
2. " " mining	.56	.68	.82	.98	1.15	1.34	1.53
3. " " manufacturing	5.78	7.15	8.56	10.50	12.19	14.09	17.74
4. " " construction	.77	.77	.95	.97	1.15	1.36	1.85
5. " " services	4.93	6.18	7.06	8.50	9.89	11.58	13.66
Exogenous Investment	3.46	5.05	7.00	8.75	10.80	13.30	15.90
I, Gross investment	17.58	22.55	27.41	33.03	38.84	45.65	54.59
F, Foreign loans	1.12	2.00	2.00	2.00	1.00	0.00	0.00
S, Domestic savings	16.46	20.55	25.41	31.03	37.84	45.65	54.59
TC, Total consumption	68.92	79.77	92.82	108.19	126.48	147.73	172.43
$GNP = TC + S$	85.38	100.32	118.23	139.22	164.32	193.38	227.02
Agricultural consumption	16.50	18.31	20.33	22.57	25.05	27.80	30.86
C, non - agricultural consumption	52.42	61.46	72.49	85.62	101.43	119.93	141.57
% / year growth of I		10.47	8.12	7.75	6.70	6.68	7.42
% / year growth of C		6.57	6.83	5.89	7.01	6.93	6.86
% / year growth of TC		6.02	6.25	6.32	6.45	6.41	6.38
% / year growth of GNP		6.66	6.60	6.76	6.86	6.73	6.63
Propensity to save (average for year 0; marginal thereafter)	.196	.274	.271	.268	.271	.269	.266
Incremental capital - output ratio		2.94	3.15	3.26	3.29	3.34	3.39

TABLE 7.

Dual Variables : Effect of "Classical" Savings Function (multiplied by 10^2)

Constraints \ Year t	1967 0	1	1972 2	3	1977 4	5	1982 6
A1t		2.411	1.607	1.072	.714	.476	.953
A2t		2.411	1.607	1.072	.714	.476	.953
A3t		2.411	1.607	1.072	.714	.476	.953
A4t		2.411	1.607	1.072	.714	.476	.953
A5t		2.411	1.607	1.072	.714	.476	.953
B1t	1.687	1.125	.750	.500	.333	.667	
B2t	2.218	1.478	.986	.657	.438	.876	
B3t	1.446	.964	.643	.429	.286	.572	
B4t	1.085	.723	.482	.321	.214	.429	
B5t	2.049	1.366	.911	.607	.405	.810	
C1							3.311
C2							3.313
C3							3.315
C4							3.315
C5							3.315
Dt	3.616						
Et	3.616						
Ft		2.411	1.607	1.072	.714	.476	.953
Gt		2.411	1.607	1.072	.714	.476	.953

ables are close to those of the basic case, Table 1. Note, however, that there is a slight difference in the time path of consumption. Because of wage-induced demands, the classical savings formulation leads to slightly higher consumption levels up to 1977, but significantly lower levels of consumption and of GNP thereafter.

Perhaps more striking than the values of the primal unknowns are those of the dual variables – together with the implications for project evaluation. In the absence of the classical savings assumption, the relative prices of the items produced in each of the five sectors do not remain constant over time. *With* the classical assumption and with the identical 20 % annual return on capital in each sector, these relative prices remain constant.** (Compare Tables 4 and 7.) Moreover, the "own" rate of return on foreign loans – and all other items – is equivalent to that produced by a 20 % annual discount rate, compounded each 2.5 years. The time structure of efficiency prices is exactly that which would emerge from von Neumann technology in which the one-period discount rate coincides with the one-period maximal growth rate, after allowing for wage-generated increases in consumption.

We conclude by pointing out that the classical savings assumption leads to a lower estimate of the leverage from foreign loans. Evidence is provided by the "own" rate of return that is implicit in the following time series of shadow prices :

period *t*	year	dual variable for foreign loan constraint Gt (normalized as ratio to dual variable for constraint Gl).	
		basic case (from Table 4)	classical savings assumption (from Table 7)
1	1969–70	1.0000	1.0000
2	1972	.4412	.6667
3	1974–75	.1946	.4444
4	1977	.0858	.2963
5	1979–80	.0379	.1975

** Within each time period, Table 7 indicates that the absolute prices are identical for each i in the material balance constraints (Ait). It is clear that the result would not have occurred if the individual items had been measured in physical rather than money units.

TABLE A. 1 1967 FLOWS AND SECTORAL IDENTIFICATION

(Units : TL. billions, 1965 prices)

Sector of destination / Sector of origin	Inter-industry deliveries	Final Demand: Consumption	Final Demand: Exports	Final Demand: Less imports	Final Demand: Fixed investment	Final Demand: Inventories	Total output	Year O output net, of interindustry demand
1. Agriculture	17.86	16.50	3.62	0	0	.82	38.80	20.94
2. Mining	1.47	.46	.27	0	0	0	2.20	.73
3. Manufacturing	20.99	24.94[a]	.82	—6.22	7.00	1.14	48.67	27.68
4. Construction	0	0	0	0	8.62	0	8.62	8.62
5. Services	26.64	27.02[b]	—.13	0	0	0	53.53	26.89
Total		68.92	4.58	—6.22	15.62	1.96		

a 48% of (total consumption - agricultural consumption - mining consumption)

b 52% of (total consumption - agricultural consumption - mining consumption).

TABLE A. 2

TECHNOLOGICAL NORMS Current account coefficients a_{ij}

Sector number i \ Sector number j	1	2	3	4	5
1.	.5100				
2.		1.000	—.0369	—.0335	—.0135
3.	—.1075	—.2100	.7264	—.3800	—.2415
4.				1.0000	
5.	—.0780	—.1260	—.0490	—.0960	.8200

Capital coefficients b_{ij}

	1	2	3	4	5
1.	.28				
2.					
3.	.34	1.84	.91	.90	.26
4.	.78		.29		1.44

Capital coefficients k_j

1	2	3	4	5
1.40	1.84	1.20	.90	1.70

Wage cost coefficients w_j

1	2	3	4	5
.0445	.2960	.4005	.3105	.2250

TABLE A. 3

DERIVATION OF CONSUMPTION DEMAND
(units : TL billions, 1965 prices)

Agricultural consumption at time $t = (1.0426)^{2.5t}$ (agricultural consumption in base year)

t	agricultural consumption
0	16.50
1	18.31
2	20.33
3	22.57
4	25.05
5	27.80
6	30.86
7	34.26

Consumption demand for sector 2 at time $t = C_{2t}$
Consumption demand for sector 3 at time $t = C_{3t}$
Consumption demand for sector 5 at time $t = C_{5t}$

$$C_{2t} = C_{2,0} + .01 \left[\frac{(1+g)^{2.5t} - 1}{g}\right] D = .46 + d_{2t}\, D$$

$$C_{3t} = C_{3,0} + .49 \left[\frac{(1+g)^{2.5t} - 1}{g}\right] D = 24.94 + d_{3t}\, D$$

$$C_{5t} = C_{5,0} + .50 \left[\frac{(1+g)^{2.5t} - 1}{g}\right] D = 27.02 + d_{5t}\, D$$

TABLE A. 4

Derivation of d_{it}

$$d_{2t} = .01 \left[\frac{(1+g)^{2.5t} - 1}{g}\right]$$

$$d_{3t} = .49 \left[\frac{(1+g)^{2.5t} - 1}{g}\right]$$

$$d_{5t} = .50 \left[\frac{(1+g)^{2.5t} - 1}{g}\right]$$

Values for g = .08,

t	d_{2t}	d_{3t}	d_{5t}
1	.03	1.30	1.32
2	.06	2.88	2.93
3	.10	4.78	4.88
4	.14	7.10	7.25
5	.20	9.90	10.11
6	.27	13.30	13.58
7	.36	17.42	17.78

TABLE A. 5

Exports and invisibles (units : TL. billions, 1965 prices)

t	Agriculture E_{1t}	Mining E_{2t}	Tourism E_{5t}	Other invisibles	Total
0	3.62	.27	—.13	.52	4.28
1	3.98	.33	.12	.90	5.33
2	4.38	.40	.63	.89	6.30
3	4.82	.49	.89	.80	7.00
4	5.30	.60	1.27	.70	7.87
5	5.83	.73	1.69	.55	8.80
6	6.41	.89	2.25	.40	9.95

TABLE A. 6

Sectoral Distribution of Exogenous Investment
(units : TL billions, 1965 prices)

t	Requirements by power and transportation (exogenous investment)	Requirements from manufacturing	Requirements from construction
0	3.46	1.94	1.52
1	5.05	2.78	2.27
2	7.00	3.85	3.15
3	8.75	4.81	3.94
4	10.80	5.94	4.86
5	13.30	7.32	5.98
6	15.90	8.75	7.15
7	18.75	10.31	8.44

TABLE A. 7

Derivation of Right - Hand Side Constants : Material Balance Constraints (A)
(units : TL billions, 1965 prices)

t	Exogenous Consumption	+ Exports	+ Exogenous investment	— Year 0 output, net of interindustry demand	= Righthand side constant
			$i = 1$		
1	18.31	3.98	—	—20.94	1.35
2	20.33	4.38	—	—20.94	3.77
3	22.57	4.82	—	—20.94	6.45
4	25.05	5.30	—	—20.94	9.41
5	27.80	5.83	—	—20.94	12.69
6	30.86	6.41	—	—20.94	16.33
			$i = 2$		
1	.46	.33	—	—.73	.06
2	.46	.40	—	—.73	.13
3	.46	.49	—	—.73	.22
4	.46	.60	—	—.73	.33
5	.46	.73	—	—.73	.46
6	.46	.89	—	—.73	.62
			$i = 3$		
1	24.94	—	2.78	—27.68	.04
2	24.94	—	3.85	—27.68	1.11
3	24.94	—	4.81	—27.68	2.07
4	24.94	—	5.94	—27.68	3.20
5	24.94	—	7.32	—27.68	4.58
6	24.94	—	8.75	—27.68	6.01
			$i = 4$		
1	—	—	2.27	—8.62	—6.35
2	—	—	3.15	—8.62	—5.47
3	—	—	3.94	—8.62	—4.68
4	—	—	4.86	—8.62	—3.76
5	—	—	5.98	—8.62	—2.64
6	—	—	7.15	—8.62	—1.47
			$i = 5$		
1	27.02	.12	—	—26.89	.25
2	27.02	.63	—	—26.89	.76
3	27.02	.89	—	—26.89	1.02
4	27.02	1.27	—	—26.89	1.40
5	27.02	1.69	—	—26.89	1.82
6	27.02	2.25	—	—26.89	2.38

TABLE A. 8

Derivation of Right - hand Side Constants :
Terminal Investment Constraints (C)
(Units : TL billions, 1965 prices)

Sector number	Exogenous Consumption demand, year 7	— Exogenous Consumption demand, year 6	+ Exogenous investment demand, year 7	— Exogenous investment demand, year 6	— Righthand side constant
1	34.26	30.86	—	—	3.40
2	.46	.46	—	—	0.00
3	24.94	24.94	10.31	—8.75	1.56
4	—	—	8.44	—7.15	1.29
5	27.02	27.02	—	—	0.00

TABLE A. 9

Derivation of Right - hand Side Constants :
Foreign Exchange Balance (F) (units : TL billions, 1965 prices)

t	— Merchandise exports excluding manufactures	— Tourism (net)	— Other invisibles	= Right-hand side constant
1	—4.31	— .12	—.90	—5.33
2	—4.78	— .63	—.89	—6.30
3	—5.31	— .89	—.80	—7.00
4	—5.90	—1.27	—.70	—7.87
5	—6.56	—1.69	—.55	—8.80
6	—7.30	—2.25	—.40	—9.95

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Ö Z E T

TÜRKİYE İÇİN BEŞ SEKTÖRLÜ BİR DİNAMİK MODEL 1967 - 82

Bu yazı İkinci Beş yıllık Plân'ın tutarlılığını kontrol için yapılmış olan makro modelin dinamik bir şekilde genişletilmesi üzerinedir. Yazıda kurulan modelin odak noktası, işgücü-artığı olan, sürekli olarak dış yardım alan ve gelecekteki politik bağımsızlığını arttırmak için ticaret dengesini düzeltmeyi plânlayan bir ekonomidir.

DPT modelinde olduğu gibi bu modelde de beş sektör vardır: Tarım, madencilik, imalât inşaat ve hizmetler. Model 1967'den 1982'ye kadar olan 15 yılı kapsamaktadır. Herbiri bir yıl uzunluğunda olan ve biribirinden 2.5 yıllık aralıklarla ayrılan aşağıdaki yıllar için sektörel dengeler hesaplanmıştır:

Yıl	Zaman Indeksi (t)
1967	0
1969–70 (Ortalama)	1
1972	2
1974–75 (Ortalama)	3
1977	4
1979–80 (Ortalama)	5
1982	6

Model, DPT modelinin tersine, dış yardım üzerine üst sınırlar koymakta ve optimizasyon tekniğinden yararlanarak ticaret dengesini düzeltici bazı faaliyetin gerekliliğini ortaya koymaktadır. Modelin dinamik olması da, her zaman kesintideki yatırım harcamalarının, geçmişteki üretim artışlarının uzantısı olarak değil de gelecekteki gerekli kapasite artmasına göre belirlenmesinden ileri gelmektedir.

Başlangıç yılı olan 1967 için yatırım harcamalarının sektörel dağılımı dışındaki bütün büyüklüklerin bilindiği var-sayılmıştır (Tablo A 1). Bitiş yılı olan 1982 için ise 1967'den 1982'ye kadar yaratılmış olan yeni kapasitenin "turnpike" oranında olacağı ve dolayısiyle sektörlerdeki bundan sonraki bütün yatırım artışlarını geometrik bir oranda devam ettireceği kabul edilmiştir.

Tüketim, maksizimize edilmesi gereken bir objektif fonksiyon olarak, tüketimi sınırlayan faktör ise tüketimin zaman içindeki yolunu belirleyen asimtotik büyüme hızı olarak alınmıştır. Marjinal tasarruf eğilimi üzerine, "klâsik" bir tasarruf fonksiyonunun postüle edildiği yer dışında hiç bir sınırlama konmamıştır.

Tüketimin zaman içinde izleyebileceği bütün yollar 1967 yılının tüketim büyüklüğü olan C_0'dan başlamakta ve tüketim zaman içinde asimtotik olarak yılda % 8 gibi bir artış göstermektedir. Bu durumda, t yılında toplam tüketim harcamaları C_t , 1967 yılındaki tüketim C_0, başlangıçtaki tüketim artışı D, ve asimtotik büyüme hızı g ile gösterilirse

$$C_t = C_0 + D \left[\frac{(l+g)^t - 1}{g} \right] \qquad t = 0, 1, 2, \ldots, +\infty$$

olmaktadır. Maksimize edilmesi gereken, $D = C_1 — C_0$ dir. Diğer bütün zaman kesitlerindeki tüketim artışları D ile orantılı olduğu için tüketim, C_0 ve g'ye verilen sabıt değerlere bağlı olarak, her zaman maksimize edilmektedir.

Modelin diğer varsayımları şunlardır: Tarım sektörü üretimi ekzojen olarak her yıl %4.26 gibi bir sabit artış gösterecektir; endüstrilerarası mal ve sermaye akımı, diğer sektörlerden tarıma doğru, tek yönlüdür; tarım, madencilik, ve görünmeyen kalemler ihracatı ekzojen olarak bulunmuştur (Tablo A 5). C_t, tarım dışı toplam tüketim harcamalarının t yılındaki değeridir, ve bundaki artışlar tarım dışı sektörlerden şu oranlarda sağlanmaktadır : Madencilikten %1, imalâttan %49, servislerden %50. Asımtotık büyüme hızı ve bu oranlar, d_{it} parametrelerini tâyin ederler. Bu parametreler, maksımıze edilecek D'nin her birimi başına, i malı için 0 ve t zamanları arasındaki tüketim talebindeki artışı gösterir (Tablo A. 4).

Amacı tüketimin maksimizasyonu olan bu doğrusal programlama modelinde 30'u malzeme dengesi; 30'u kapasite sınırı; 5'i yatırım üzerindeki son devre sınırı; 7'sı gayrisafî yatırım tanımı; 7'si iç tasarruf, yatırım ve dış borçlar arasındaki ilişki; 6'sı döviz dengesı; 6'sı dış borç üzerindeki üst sınır olmak üzere 91 tane sınırlama vardır (Tablo A 7, A 8, ve A 9'da sınırlamalardan bazılarının sabit katsayılarının nasıl elde edildıgı gösterilmiştir).

Modelin kabullerinden bir tanesi de Türkiye ekonomisinin büyümesinin ne iş gücü büyümesi ne de iş gücü üretkenliğindeki artış tarafından sınırlandırılmayacağıdır. Temel olarak büyümeyi sınırlandıran öğeler döviz ve sermaye birikimi sınırlarıdır. Asimtotik büyüme hızının g = 0.08 alındığı ve dış borçların 1, 2 ve 3. zaman kesitlerinde 2 milyar TL., 4. zaman kesitinde 1 milyar TL. olduğu kabul edildiği zaman elde edilen sonuçlar 1. tabloda gösterilmiştir (5. zaman kesitınde ve daha sonra hiç dış borç alınmayacağı varsayılmıştır). Bu durumda görülmektedir ki, sonuçlar İBYP'ın GSMH için %7, imalât sanayi üretimı ıçın %12 olarak öngördüğü hedeflerden biraz daha düşüktür. Eğer büyüme hızı %10 olarak alınırsa sonuçlar İBYP hedeflerine biraz daha yakın olmaktadır (Tablo 2).

Büyüme hızının %8 değil de %10 olması ilk üç zaman kesitinde hemen hemen hiç değişıklık getirmemekte fakat 4. zaman kesitınden (1977) sonra tüketimde daha büyük artışlar olmaktadır (Bunun 2 no.lu şekilde de görmek mümkündür).

Asimtotik büyüme hızının %8 olarak alınması ve dış borçların büyük ölçüde azalması durumunda ortaya çıkan sonuçlar Tablo 3'te gösterilmiştir. Politik bağımsızlık yolunda atılan bu adımın ekonomik sonucu, tüketimin azalması, marjinal tasarruf eğiliminin ve iç güçlüklerin artması biçimmde olmaktadır.

Tablo 1 ve 3'ün karşılaştırmasından dış borçların marjinal üretkenliği hakkında bir fikir edinmek mümkündür. 1967 - 1977 yılları arasında dış borçlar sürekli olarak 1 milyar TL. daha eksik olursa 1982 yılında GSMH'da 4 mılyar TL. bir düşüş meydana gelmektedir.

Başlangıç yılı için yapılan ve yatırımların sektörlerarası dağılmının daha önceden belirlenmiş bir toplam miktara eşit olmasını gerektiren varsayımın yanısıra her sektöre yapılan yatırımların gerçek miktarlarını bildiğimiz varsayımını yaparsak Tablo 5'te gösterilen sonuçları elde ederiz. Bu durumda tuketim ve GSMH'da keskin bir düşüş görülmektedir.

Bundan sonra, işçi ücretlerinin sıfırdan farklı olduğunu kabul eden ve fiziksel sermayeye daha az kaldıraç gücü atfeden "klâsik" bir tasarruf fonksiyonu üzerinde durulmuştur. Burada merkezî plânlama otoritesinin işçilerin tüketiminin izleyeceği yolu etkileyecek kadar kudretli olmadığı fakat üretimdeki artışların ücret gelirlerinde oransal bir artışa yol açtığı ve dolayısiyle işçilerin tüketim mallarına karşı olan taleplerini arttırdığı varsayılmıştır.

Tüketimin zaman içinde izleyeceği yol bu durumda

$$C_t = C_0 + \sum_{j=1}^{5} W_j\, t + D \left[\frac{(1+g)^t - 1}{g} \right]$$

olmaktadır. Burada W_j, j sektöründe her üretilen birim başına marjinal ücret gelirini, D ise ilk zaman kesitinin ücret dışı tüketimindeki artışı göstermektedir. Sermayenin gayri safî kazanç oranı %20 varsayılmış ve Tablo 2'de gösterilen ücret katsayıları $W_j = \sum_{i=1}^{5} aij - .20\, k_j$ formülünden bulunmuştur.

Klâsik bir tasarruf fonksiyonunun postüle edildiği bu denemede D maksimize edildiği zaman görülmektedir ki, tüketim düzeyi, Tablo 1'den farklı olarak, çok az bir artış göstermekte, fakat bundan sonra hem tüketim hem de GSMH göze çarpar bir biçimde düşmektedir (Tablo 6).