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GROWTH-ORIENTED ADJUSTMENT TO EXTERNAL SHOCKS: AN APPLICATION TO TURKEY

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I. INTRODUCTION

FOR the developing economies, the period of 1973–83 was one of severe external shocks, balance of payments crises, and macro disequilibria. These shocks included the drastic increase in oil prices in 1973–74, and then in 1979–80; the global recession and the concurrent protectionist threat; high interest rates and exchange rate instability; and reduced foreign capital inflows.

The experiences of individual countries reveal that the extent and the impact of the external shocks have been different in scope and nature in each particular economy, and that the modes of adjustment accordingly varied from country to country [18] [8]. Nevertheless, previous policy advice has been limited largely to the classic trade theory prescriptions of trade liberalization and the general advocacies of expenditure reswitching along with domestic credit restraint (see, e.g., [20] [26]).

However, both theoretical and empirical evidence thus far accumulated suggests that the effects of such stabilization could be stagflationary [16] [29] [15] and produce unjustifiably high social costs of unemployment with worsening income distribution [17].

Thus, one witnesses growing evidence on the part of researchers and policy-makers to develop a policy framework for an adjustment program which is "growth-oriented" [21] [9]. Designing such a program which is simultaneously aimed at the stabilization of macro balances, especially that of external payments, and at the revitalization of potential output capacity is certainly a challenging task. It is by no means clear what the optimal mix of policy instruments should be that would integrate broad objectives of growth, elimination of internal and external disequilibria, and improved individual welfare.

The present paper attempts to shed more light on this issue by employing methods of stochastic optimal control theory to a computable general equilibrium (CGE) model of Turkey. Focusing on the period of Turkey's Fourth Five-Year

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Development Plan (1979–83), the CGE model is used as a planning device to simulate the stylized components of the 1979 shock. Following this, techniques of dynamic programming are utilized to obtain a set of "optimal" policy control instruments which would have minimized the disturbances of the shocks. Once contemporaneous elements of such a set are identified, they are further contrasted with the actually realized control instruments and the extent that these were employed. In so doing, conclusions are inferred about the optimality of the implemented structural adjustment package itself.

The CGE model is in the Adelman-Robinson [1] tradition in its characterization of the domestic market structure and dynamics; and in the Dervis-Robinson [13] tradition in its characterization of foreign trade. The choice was due to the fact that these two traditions allow for the maximum medium-term sensitivity to external balances in the determination of the pace of capital accumulation and growth, the prime foci of this study.

In general terms, the paper is organized as follows: in the next section, the main elements of the Turkish structural adjustment experience are discussed. Section III introduces the methodology and describes the optimal control techniques that are used in the model. The "optimal" adjustment rules as suggested by the model are derived and contrasted with the actual reform program in Section IV. Section V is reserved for further discussion and summary comments. Finally, the computable general equilibrium model used in the paper is described in the Appendix.

II. ELEMENTS OF TURKISH STRUCTURAL ADJUSTMENT

Against the first oil shock of 1973/74, Turkish adjustment policies relied on increased foreign borrowing rather than revising the growth targets. The share of fixed investments in GNP increased from 17.5 per cent in 1963–73 to 22.7 per cent in 1974–76; and the per capita GNP growth rate accelerated from 3.2 per cent during the 1960–73 period to 5.2 per cent in 1973–76. The availability of foreign credit enabled Turkey to continue its growth drive without any major adjustments in the exchange rate. This lack of adjustment in turn brought about a significant reduction in incentives to export, and the real exchange rate appreciated by 13.2 per cent [5]. As these conditions were culminating into an economic crisis, the Turkish economy was hit by the second oil shock of 1979/80. Initial stabilization attempts in 1979 brought mixed results. While the current account deficit improved, domestic inflation accelerated. Foreign borrowing having been stretched to the maximum could not be increased further, and imports had to be reduced substantially. Capacity utilization rates in industry fell and the growth rate of real GNP fell to −0.4 per cent in 1979 and to −1.1 per cent in 1980.

On January 24, 1980 a new government finally introduced a set of extensive policy reforms which aimed not only at short-run stabilization, but also at changing the structure of the economy, moving it toward a more outward orientation by increasing the role of the private sector and the market forces. Further, a change in sectoral priorities occurred in favor of export-oriented manufactures and com-

TABLE I

REALIZED AND PLANNED LEVELS OF SELECTED POLICY INSTRUMENTS FOR THE FOURTH PLAN SIMULATION

	1978	1979		1981		1983	
		Realized (%)	Planned (%)	Realized (%)	Planned (%)	Realized (%)	Planned (%)
Exchange rate[a]	24.3	36.4	28.6	108.6	87.2	212.0	126.6
Tariffs on:							
Agriculture	20.3	26.4	20.3	26.4	20.3	26.4	20.3
Food processing	23.5	53.8	23.5	53.8	23.5	42.9	23.5
Textiles, clothing	48.8	65.2	48.8	65.2	48.8	52.0	48.8
Intermediates	35.2	44.5	35.2	44.5	35.2	35.5	35.2
Capital goods	35.0	38.5	35.0	38.5	35.0	30.7	35.0
Export subsidies for:							
Agriculture	0.2	0.2	0.2	0.6	0.2	0.6	0.2
Food processing	0.9	4.4	4.4	11.7	4.4	10.6	4.4
Textiles, clothing	1.8	10.6	10.6	18.9	10.6	22.1	10.6
Intermediates	4.3	6.8	6.8	20.3	6.8	27.1	6.8
Capital goods	4.9	18.9	18.9	54.8	18.9	46.1	18.9
Public investment in:							
Agriculture	10.1	7.2	12.2	9.5	12.2	11.4	12.2
Food processing	3.4	3.1	3.0	4.7	3.0	3.6	3.0
Textiles, clothing	2.3	5.9	3.4	1.7	3.4	1.3	3.4
Intermediates	18.4	21.7	21.0	24.0	21.0	18.4	21.0
Capital goods	3.5	5.8	6.0	3.5	6.0	2.7	6.0
Services	62.3	56.3	54.4	56.6	54.4	62.6	54.4
Aggregate fixed investment[b]	279.6	263.1	292.9	246.8	362.4	275.7	403.8
(% in GNP)	(21.9)	(20.8)	(21.0)	(19.3)	(24.0)	(19.2)	(24.4)

Sources: Exchange rate: OECD Economic Surveys. Tariffs: for 1978, 1979, and 1981 (agriculture), [23]; for 1979 and 1981 (manufacturing), [41, Table 2.24a]; for 1983, [7]. Also see text. Export subsidies: for 1978, [23]; for 1979, [41, appendix b. 1, p. 111]; for 1981 and 1983, [28]. Public investment: for agriculture, [19]; for manufacturing, [42, p. 12]. Total fixed investment: [37, various issues].

a Domestic currency units (TL) per foreign currency ($). The planned (%) column corresponds to the "equilibrium" exchange rate endogenously solved by the model to close the balance of payments accounts given the Plan's projections of foreign exchange inflows.

b 1978 billion TL.

mercial services. The 1980 structural adjustment program contained a set of far-reaching policies.[1] The Turkish lira was devalued sharply and a crawling peg regime of foreign exchange administration was adopted. An extensive direct export promotion scheme was introduced which consisted of income tax rebates, preferential credit arrangements, and duty free allowances for intermediate imports.

[1] See [14] and [31] for a comprehensive evaluation of Turkish structural adjustment policies since 1980.

The direct export subsidy rate on exports ranged between 20 per cent (1981) and 23 per cent (1983) [23]. Import procedures were restructured and by 1981 the waiting period for import licences had been significantly reduced. But compared with the policies toward export promotion, the pace of import liberalization was slower and was not implemented until 1983.[2] (For an evolution of the export subsidy and tariff protection policies, see Table I.)[3] Finally, commensurate with the philosophy of reducing state involvement, public investments were reduced sharply below their previous levels.

As a result of these measures, exports increased sharply and industrial value added rose by 7.2 per cent. However, due to strict monetary policies and reductions in domestic absorption, business conditions remained generally sluggish. Domestic private investment stagnated and recovered its 1979 level in real terms only after 1985. Real wages in manufacturing fell sharply, at an average rate of -7.7 per cent per annum during 1979–83.[4]

Table II presents the main economic indicators during the 1978–83 period. One can see that, based on Turkey's historical standards, real GDP growth has been modest, averaging 2.3 per cent per annum over the plan period. Accordingly, the growth in the domestic uses of GDP, through fixed investment and consumption, were hesitant, averaging -0.6 per cent per annum for the former, and 0.5 per cent for the latter. This observation suggests that during the analyzed period the sources of growth came not from the domestic economy, but from outside via increased export demand.

Tables I and II provide other pertinent information on the use of policy instruments and the state of the economy during the plan period, and more extensive analyses of the policy environment during this period can be found in sources [31], [32], and [41]. With this we now turn to a discussion of the elements of the optimal control methodology that will be used in this paper.

III. METHODOLOGY

A. *The Optimal Adjustment Problem*

The elements of the optimal control methodology employed in this paper draw on the previous formulation by [2] and applications of [4].

We start by first assuming that the general equilibrium structure of the economy is governed by a continuously differentiable vector system of implicit functions taking the form of

2 Based on his CGE simulations, Celasun [7] reports that quantity rationing on Turkish imports continued as late as 1983.

3 The realized sectoral tariff rates of Table I were adopted from the World Bank 1982 study and from [23]. Such data was not available for 1983. However, Celasun [7, Table B-9] reports that the manufacturing industry average tariff rate has been reduced only marginally from 29.7 per cent in 1981 to 23.7 per cent in 1983. Following Celasun's figures, the 1981 sectoral tariff rates have been scaled down by the rate of reduction of the average tariff rate to obtain the estimates for 1983.

4 For an extensive review of the Turkish labor market in this period, see [33].

TABLE II

REALIZED, PLANNED, AND SIMULATED LEVELS OF MAJOR ECONOMIC INDICATORS DURING THE FOURTH PLAN

	1978[a] (Billion TL)	1983 (1978 Billion TL)			1978–83 Annual Growth Rates (%)		
		Realized	Fourth Plan	Fourth Plan CGE Simulation	Realized	Fourth Plan	Fourth Plan CGE Simulation
Expenditures							
GDP (at market prices)	1,140.2	1,277.5	1,693.3	1,655.1	2.3	8.2	7.7
Aggregate investment	228.1	222.2	410.5	403.8	−0.6	12.5	12.1
Private	106.6	82.9	176.7	183.7	−5.9	10.6	11.5
Public	121.5	139.3	233.8	220.1	2.8	13.9	12.6
Consumption	957.1	979.7	1,305.8	1,299.1	0.5	6.4	6.3
Private	788.2	792.1	1,039.6	1,075.1	0.1	5.7	6.4
Public	168.8	196.1	266.2	224.0	3.0	9.5	5.8
Sectoral value added							
Agriculture	253.1	281.5	328.0	319.9	2.2	5.3	4.8
Industry	336.4	363.9	538.1	510.7	1.6	9.9	8.7
Services	550.7	625.9	827.2	824.5	2.6	8.5	8.4
Capital stocks[b]							
Agriculture	680.7	n.a.	n.a.	795.7	n.a.	n.a.	3.2
Consumer manufacturing	203.8	n.a.	n.a.	288.1	n.a.	n.a.	7.2
Producer manufacturing	634.2	n.a.	n.a.	954.0	n.a.	n.a.	8.5
Services	2,108.4	n.a.	n.a.	2,716.0	n.a.	n.a.	5.2
Average manufacturing wages[c]	100.0	68.4	n.a.	109.6	−7.3	n.a.	2.0
Foreign trade							
Exports	57.5	121.3	135.0	129.4	16.3	18.6	17.6
Agriculture	22.0	40.0	31.2	30.1	12.7	7.2	6.5
Manufacturing industry	35.5	81.3	103.8	99.3	19.2	25.6	22.8
Imports							
Consumer manufacturing	2.6	4.2	4.4	4.5	10.3	11.1	11.6
Producer manufacturing[d]	110.7	139.3	181.2	182.1	4.7	10.4	10.5

Sources: [36, various issues] [37, various issues] [38] [39, supplementary texts] [41, data tables].

[a] Fourth Plan estimates for 1978.

[b] Capital stock data borrowed from [24] and utilized in the CGE model simulations.

[c] Indexes of real wages based on Istanbul CPI.

[d] Includes mining and oil.

$$S_t = f(S_t, S_{t-1}, I_t, z_t), \tag{1}$$

where S_t is an $n \times 1$ vector of endogenous variables representing the "state" of the economy at period t; S_{t-1} is the vector of their lagged values; I_t is an $m \times 1$ vector of policy instruments under the direct control of the policy authority; and z_t is a $k \times 1$ vector of exogenous variables which are outside the control of the authority. The time index t is an element of the planning horizon $\{1, \ldots, T\}$ with T being the terminal period of the plan. In our case, this horizon runs from 1979 through 1983.

We next assume that over this period the policymakers have a devised targeted path for the "state" variables in the form of

$$\overline{S}_t = f(\overline{S}_t, \overline{S}_{t-1}, \overline{I}_t, \overline{z}_t), \tag{2}$$

where the variables now indicate the targeted/projected values of the respective variables in (1).

Observe, however, that the components of z_t are exogenous to the plan and their projected values are prone to external "shocks." Their particular realizations can thus be characterized as a set of random variables with

$$z_t = \overline{z}_t \pm \varepsilon_t, \tag{3}$$

where ε_t is a vector of disturbance terms (shocks) and are assumed to have zero means and be serially and contemporaneously uncorrelated.

Once the plan is initiated, it is plausible to expect that the realizations of z_t will deviate from their projected levels $\overline{z}_t$. Should such deviations become larger than an "acceptable" level, it will be necessary to revise the instruments vector to keep the economy on its targeted path (2). Thus, simply put, in the presence of unexpected external shocks, the optimal adjustment problem is one of revising the time path of the control instruments I_t, such that the deviations of the S_t "state" variables from their targeted values are minimal.

Let us now denote the deviations of the relevant variables from their targeted paths by using the notation: $\Delta V = V - \overline{V}$, with $V_\varepsilon \ \{S_t, S_{t-1}, I_t, z_t\}$. The problem formally becomes minimizing the expected ΔS_t deviations, subject to the structural constraints (1). Or, stated algebraically,

$$\underset{\{I_t\}}{\text{Min}}\ E \sum_{t=1}^{T} \Delta S_t' Q_t \Delta S_t, \tag{4}$$

subject to $S_t = f(S_t, S_{t-1}, I_t, z_t)$.

In (4) the $n \times n$ diagonal matrix Q_t is used to measure the extent that the policy authority will tolerate the "state" variables to deviate from the targeted values. A higher weight on any element of Q_t indicates a smaller tolerance for deviations, and vice versa.

Even though the objective function in (4) is well behaved, the depiction of its constraint function is difficult to control in a CGE modeling framework because of its high degree of nonlinearity. Therefore we will linearize the system by expressing the path of deviations of the "state" variables in terms of their Jacobians around their respective targeted values. The total differential of (1) gives

$$dS_t = J_s(t)dS_t + J_s(t-1)dS_{t-1} + J_I(t)dI_t + J_z(t)dz_t, \tag{5}$$

where the matrices $J_v(i)$ represent the Jacobians of the structural equation system with respect to the variable $V_\varepsilon \{S_t, S_{t-1}, I_t, z_t\}$.

Using the differential expression (5) we can obtain a linear approximation to the transition equations:

$$\Delta S_t = A_t \Delta S_{t-1} + B_t \Delta I_t + C_t \Delta z_t, \tag{6}$$

where

$A_t = [I - J_s(t)]^{-1} J_s(t-1),$
$B_t = [I - J_s(t)]^{-1} J_I(t),$
$C_t = [I - J_s(t)]^{-1} J_z(t).$

B. *Bellman's Equations*

We will now apply standard dynamic programming methods to generate the optimal adjustment rules for the instruments vector. For a general exposition of this methodology, the interested reader is referred to [30].

We can recast our linear-quadratic minimization problem in a one-period Bellman's value function format as follows:

$$W_t(\Delta S_{t-1}, \Delta z_t) = \underset{\{\Delta I_t\}}{\mathrm{Min}} [\Delta S_t' Q_t \Delta S_t + E_t W_{t+1}(\Delta S_t, \Delta z_{t+1})], \tag{7}$$

subject to (6) above. In (7), the E_t is the conditional expectation operator, given information available in period t. Following Bellman's recursion and noting that $W_{T+1} = 0$, for the terminal period this expression becomes

$$W_T(\Delta S_{T-1}, \Delta z_T) = \underset{\{\Delta I_T\}}{\mathrm{Min}} \Delta S_T' Q_T \Delta S_T.$$

The first order necessary condition for this problem will be

$$\partial W_T / \partial I_T = 2 B_T' Q_T (A_T \Delta S_{T-1} + B_T \Delta I_T + C_T \Delta z_T) = 0, \tag{8}$$

which can be solved for the terminal period optimal instrument adjustment rule ΔI_T^*,

$$\Delta I_T^* = -(B_T' Q_T B_T)^{-1} B_T' Q_T (A_T \Delta S_{T-1} + C_T \Delta z_T). \tag{9}$$

Equation (9) gives a general description of the optimal instrument adjustment in the presence of shocks. We will assume that the "shock" has occurred only once, in the initial stages of the plan period. Denoting the period that the shock has occurred by τ, we then have $\Delta z_t = 0$, for $t > \tau$. We can then use (6) and (9) to obtain the optimal "state" variable adjustment of the terminal period,

$$\begin{aligned}\Delta S_T^* &= A_T \Delta S_{T-1} + B_T \Delta I_T^* \\ &= A_T \Delta S_{T-1} - B_T[(B_T' Q_T B_T)^{-1} B_T' Q_T (A_T \Delta S_{T-1})] \\ &= [I - B_T (B_T' Q_T B_T)^{-1} B_T' Q_T] A_T \Delta S_{T-1}.\end{aligned} \tag{10}$$

An important feature of this solution is that, although the Bellman's value function is "stochastic" in nature due to the presence of the random component ε_t, the optimal decision rule as depicted by (10) is independent of the covariance matrix of ε_t. This feature is called the "certainty equivalence principle," and it is a special property of the optimal linear regulator problem at hand.[5] The implication of this principle is that under such conditions the optimal decision rule will be identical with that of the non-stochastic (deterministic) optimal control problem. Unfortunately, this principle does not characterize stochastic control problems generally.

Given (10), the quadratic expected value function under optimal adjustment for the terminal period becomes

$$W_T(\Delta S_{T-1}, 0) = \Delta S_{T-1}' M_T \Delta S_{T-1}, \tag{11}$$

where

$$M_T = A_T'[Q_T - Q_T B_T (B_T' Q_T B_T)^{-1} B_T' Q_T] A_T.$$

Continuing with the recursion back to period $T-1$, we now solve for

$$W_{T-1}(\Delta S_{T-2}, 0) = \min_{\{\Delta I_{T-1}\}} [\Delta S_{T-1}' Q_{T-1} \Delta S_{T-1} + E_{T-1} W_T(\Delta S_{T-1}, 0)], \tag{12}$$

which, by substituting the optimal value of W_T from (11), becomes

$$W_{T-1}(\Delta S_{T-2}, 0) = \min_{\{\Delta I_{T-1}\}} [\Delta S_{T-1}'(Q_{T-1} + M_T)\Delta S_{T-1}]. \tag{13}$$

We can now generalize to get the solution to the problem for the periods *subsequent to the shock, $t > \tau$*,

$$\Delta I_t^* = G_t \Delta S_{t-1}, \tag{14}$$

where

$$G_t = -[B_t'(Q_t + M_{t+1})B_t]^{-1} B_t'(Q_t + M_{t+1})A_t,$$
$$M_t = A_t'(Q_t + M_{t+1})\{I - B_t[B_t'(Q_t + M_{t+1})B_t]^{-1} B_t'(Q_t + M_{t+1})\}A_t,$$
$$M_{T+1} = 0.$$

For the *period of the shock,* the optimal adjustment rule will be

$$\Delta I_\tau^* = H_\tau \Delta z_\tau, \tag{15}$$

with

$$H_\tau = -[B_\tau'(Q_\tau + M_{\tau+1})B_\tau]^{-1} B_\tau'(Q_\tau + M_{\tau+1})C_\tau.$$

Thus far, we have obtained a set of ex ante rules which can be applied ex post in the presence of shocks, so that the deviations of the "state" variables from their targeted paths will be minimal. Given the once-only shock at period τ, we can further deduce the optimal path for the evolution of the "state" variables. In the period of the shock the net effect on the "state" variable deviation will be

[5] Very broadly the "certainty equivalence principle" asserts that when the objective function is quadratic and the uncertainty is not multiplicative in the control variable, then the solution of the stochastic optimization is equivalent to the solution of non-stochastic optimization with future variables being replaced by the optimum projection of those variables.

$$\begin{aligned} \Delta S_\tau^* &= B_\tau \Delta I_\tau^* + C_\tau \Delta z_\tau, \\ &= (B_\tau H_\tau + C_\tau)\Delta z_\tau, \end{aligned} \tag{16}$$

while $\Delta S_{\tau-1} = 0$, because no shock has occurred before τ.

The fact that policy adjustment was optimal in the first period does not guarantee that the economy will instantaneously fit back in to its targeted path. Deviations in S_τ, although as minimal as possible, will induce further deviations in the subsequent periods via the structural dynamics of the economy. These subsequent deviations can be encountered using the G_t $(t > \tau)$ matrices of equation (14),

$$\begin{aligned} \Delta I_{\tau+1}^* &= G_{\tau+1} \Delta S_\tau^* \\ &= G_{\tau+1}(B_\tau H_\tau + C_\tau)\Delta z_\tau, \end{aligned} \tag{17}$$

and the "state" variables will move along the path

$$\begin{aligned} \Delta S_{\tau+1}^* &= A_{\tau+1} \Delta S_\tau^* + B_{\tau+1} \Delta I_{\tau+1}^* \\ &= (A_{\tau+1} + B_{\tau+1} G_{\tau+1})(B_\tau H_\tau + C_\tau)\Delta z_\tau. \end{aligned} \tag{18}$$

In general, assuming no new shocks in the subsequent periods, the optimal laws of motion of policy adjustment and the resulting "state" variable deviations will follow

$$\Delta I_t^* = N_t \Delta z_\tau \text{ and } \Delta S_t^* = P_t \Delta z_\tau, \tag{19}$$

where

$$\begin{aligned} N_t &= G_t P_{t-1}, \\ P_t &= (A_t + B_t G_t) P_{t-1}, \end{aligned} \tag{20}$$

with the initial conditions given by (15) above.

The matrix pairs $\{N_t, P_t\}$ measure the optimal instrument adjustments and the implicated minimal deviations of the "state" variables in response to an external shock, like that of 1979. Reiterating our purpose, the rest of the paper is devoted to the derivation of the N_t and the P_t matrices for the Turkish economy during the Fourth Plan period, 1979–83. Once these matrix pairs are computed, they can further be used as a benchmark to infer conclusions about the optimality of the actually implemented structural adjustment program in that period.

IV. ANALYSIS

A. *CGE Simulations of the Fourth Plan and the 1979 Shock*

The optimal adjustment path of the economy is computed using the CGE model as a planning device and applying the elements of the control methodology discussed in the previous section. More explicitly, we will use the Fourth Plan document as a benchmark for such comparisons, as it unambiguously gives a quantifiable description of, in the terminology of the previous section, the official targeted growth path, deviations from which ought to be minimized. Thus, we will use the planned values as a functional delineation of equation (2) above.

The Fourth Plan carried an average growth rate target of 12.4 per cent for gross investment in constant billion liras and envisaged that the share of gross investment in GDP be increased from 20.8 per cent in 1979 to 24.4 per cent in 1983. The investment target would partly be financed by external borrowing which was projected to reach a total of U.S.$8.0 billion or US$1.6 billion per annum in constant 1978 prices. With a projected world inflation rate of 7.8 per cent per annum this would mean a net annual inflow of U.S.$2.0 billion. Finally, the plan expected no changes in the relative terms of foreign trade and projected that the volume of merchandise imports would grow at an annual rate of 10.5 per cent, with a projected rate of 9.9 per cent growth for intermediate imports.

For the simulation exercise, the values of most of the major exogenous variables were adapted from the State Planning Organization's plan document. For the trade-related policy instruments, however, explicit targeted levels were not available in the plan document, except for descriptive guidelines for tariff protection and export promotion. In the absence of further detailed information, the targeted levels of the tariff rates were set to their 1978 values. As for the export subsidy instruments, since the vigorous export promotion program was actually initiated in 1980–81, the 1979 realized figures were assumed to reflect the planning authority's desired subsidy rates for attaining the export targets. Further, the exchange rate was endogenously calculated by the CGE model to close the balance of payments accounts under the plan's projections with respect to exogenous capital inflows and trade performance.

On the production side the growth rate of real wages in manufacturing was set at 2 per cent per annum. The technical coefficient growth rates were calibrated parametrically to track the plan's sectoral growth projections.

As observed from Table II, the values of the major "state" variables of the plan were closely tracked by the CGE simulation effort, though the overall growth performance of the economy still fell short of the plan's targets. Further, with respect to foreign trade, there was a slight tendency for under-export and over-import as compared to the targeted levels, the implication being that the simulated currency depreciation would be larger had a perfect fit been possible.

The external shock of the 1979/80 period was simulated in one single-shot of three stylized strokes to the domestic economy. First, the world import price of intermediate goods (which includes oil in the aggregation scheme of the CGE model) was increased parametrically by 60 per cent over its simulation value of 10 per cent for the plan. Second, to account for the unexpected losses of foreign capital sources in 1979, the amount of external borrowing by the government was reduced by U.S.$1.0 billion. Finally the (Hicks-neutral) technical growth coefficients in manufacturing were reduced to nill to simulate the crisis condition in industrial production. In order to account for the continuing convulsions of the shock through 1980 and 1981, and the already existing crisis conditions due to the first oil shock, the "single-shot 1979 shock" was somewhat exaggerated in the CGE simulations. Thus, for example, when simulated over the 1979 CGE solutions, the loss in the value of gross domestic product over its planned target was calculated to reach 8.2 per cent. This figure can be contrasted with the previous estimates which revealed that after the 1979/80 shock, the Turkish economy lost 4.7 per cent over its *potential* GNP [18]. A previous estimate, reported in the 1982 World Bank country study on Turkey, indicated that the combined effects of the external shocks from 1974–78 had been on the order of 5.4 per cent of the *actual* GNP during that period [41].

At the sectoral level, the CGE simulations reveal that the most devastating component of the shocks was that of the price shock to intermediate imports, followed by the balance of payments shock of decreased foreign exchange. The simulated effect of a 60 per cent rise in import prices slowed the targeted growth rate of GDP by 1.4 percentage points. The total cost of intermediate imports was calculated to be close to 6.8 per cent of GDP following the shock. The trade deficit increased by 18 per cent over the envisaged value of the plan.

The productivity shock, on the other hand, had a direct impact on real manufacturing output, causing it to fall by 6 per cent compared to its targeted value. Skilled labor employment and real wages in manufacturing fell by 1.5 per cent and by 1.8 per cent, respectively. The simulation of this shock experiment revealed that the real effects of the productivity decline was modest in the immediate short run as compared to the trade shocks. However, over the medium run, the convulsions of declining productive capacity became more severe.

Thus given the sizable shocks both from the trade and the production side, the next task is to derive the optimal adjustment rules based on the optimal control methodology introduced above.

B. *The Optimal Adjustment Path*

The optimal control methodology is utilized to minimize the shock-induced deviations of the following "state" variables from their Fourth Plan's target values: sectoral gross output supplies; sectoral physical capital stocks; the average manufacturing wages; private consumption; consumer and producer manufacturing exports; and the merchandise trade balance. All variables are valued at real 1978 prices.

The control instruments are selected with special emphasis on the policy variables mostly associated with the structural adjustment reform programs: the exchange rate, sectoral tariffs and export subsidies for merchandise goods, aggregate fixed investment, and its sectoral allocation. Thus, the vector of control instruments consists of eighteen variables.

The Q matrix of "state" variable control weights used in equation (4) of the expected quadratic loss function is differentiated according to whether the relevant variable is associated with the "growth" or the "stabilization" objective. To recall, this matrix reflects the tolerance of the policy authority to allow deviations of the "state" variables from their targeted paths. For the stabilization-related variables (manufacturing wages, private consumption, manufacturing exports, and the trade balance) the elements of this matrix are determined from the J matrix of Jacobians and set equal to the derivatives of the gross domestic product with respect to the relevant variable. As for the growth-related variables, the sectoral outputs are weighted according to their respective shares in aggregate gross output, while the physical capital stock weights are set equal to the product of respective output-capital ratios and the sectoral shares in aggregate gross output. To achieve further consistency among the simultaneous objectives of growth and stabilization, the weights are normalized around one within the variables associated with each objective category. The diagonal elements of the Q matrices are displayed in Table IV.

C. *The Optimal Instrument Adjustments*

The N matrix of optimal instrument adjustment rules is shown in Table III. This matrix shows the rates of change in the relevant instruments in response to a unit change in the exogenous shocks. These decision rules are derived from the recursive application of equations (19) and (20). In the shock period, the N matrix corresponds to the H matrix of the initial period of adjustment. In latter periods, it is derived as composite optimal policy rules induced by earlier adjustments and states of the economy.

In general, the most notable feature of the optimal adjustment rules is their complex and multidimensional nature, both qualitatively and quantitatively. Further, optimal policy response is observed to be spread over time and adjustment continues throughout the whole plan period. Generally speaking, however, a comparison of the initial and final periods shows that the magnitudes of adjustment elasticities tend to diminish in absolute value. These observations suggest that the mode of policy reforms necessary to combat the given shocks was indeed one of "structural adjustment" with a detailed and intensive design of various instruments rather than the "single-shot," "stand-by" measures of classic short-term stabilization.

A closer inspection of Table III indicates that currency appreciation was an optimal initial response to both the trade and the production shocks, but that continued devaluation was optimal in the latter periods. Thus, with respect to exchange rate administration, the optimal adjustment rules suggest a brief "grace" period in which the domestic economy was shielded, to be followed by gradual absorption of the shocks via steady depreciation.

This kind of exchange rate adjustment is clearly the result of the import-intensive character of the Turkish economy. As intermediate imports became more expensive due to devaluation, industry contracted with recessionary consequences for the whole economy. Such "contractionary" effects of devaluation is mostly emphasized in "structuralist" literature (e.g., [22] [40] and also in the Turkish context by [10]).[6]

With respect to tariffs, the optimal policy response is observed to be sector and shock specific. Rather than a uniform movement, the optimal tariff-protection

[6] Conway's own econometric simulations, for instance, indicate that the realized devaluation policy of the early eighties has discouraged private investment and its effectiveness was mostly due to expenditure switching. Thus, the Turkish devaluation policy of 1979–83 seems to be non-optimal given the objectives of growth and capital accumulation. See [25] for a recent survey of the contractionary effects of devaluation in the developing countries.

TABLE III

OPTIMAL INSTRUMENT ADJUSTMENT (N MATRICES)

	1979			1981			1983		
	$N(i,1)$	$N(i,2)$	$N(i,3)$	$N(i,1)$	$N(i,2)$	$N(i,3)$	$N(i,1)$	$N(i,2)$	$N(i,3)$
Exchange rate	−0.496	−0.416	−1.951	1.314	0.831	1.976	1.958	1.233	2.977
Tariffs on:									
Agriculture	8.131	4.185	5.952	−10.308	−6.447	−15.902	−2.764	−1.725	−4.295
Food processing	−8.456	−4.072	0.469	−10.311	−6.527	−15.487	2.345	1.507	3.407
Textiles, clothing	0.238	0.005	−5.189	3.091	1.944	4.713	8.285	5.184	12.794
Intermediates	−3.041	−0.592	−4.164	−5.271	−3.331	−7.944	−2.207	−1.364	−3.501
Machinery	3.375	0.809	23.478	7.229	4.579	10.848	−18.582	−11.769	−27.835
Export subsidies for:									
Agriculture	−2.025	−0.531	0.741	−1.628	−1.071	−2.231	−16.167	−10.455	−23.019
Food processing	2.543	0.622	−3.968	18.357	11.594	27.726	3.853	2.463	5.649
Textiles, clothing	−0.189	−0.188	2.469	−6.739	−4.232	10.302	−7.638	−4.828	−11.511
Intermediates	0.587	−0.017	5.789	4.187	2.657	6.255	−2.281	−1.443	−3.436
Machinery	−0.109	0.017	1.567	−0.949	0.596	1.441	−9.103	−5.649	−14.309
Public investment in:									
Agriculture	0.012	0.008	0.018	−0.019	−0.011	−0.028	0.146	0.091	0.229
Food processing	0.001	0.002	−0.018	−2.192	−1.354	−3.483	3.691	2.326	5.597
Textiles, clothing	0.007	0.005	0.384	−0.398	−9.199	−0.681	3.657	2.305	5.551
Intermediates	0.046	0.029	−0.023	−1.382	−0.873	−2.083	5.464	3.436	8.335
Machinery	−0.001	0.001	0.054	−0.571	0.359	0.873	3.131	1.968	4.784
Services	0.575	0.149	3.101	19.317	12.234	28.977	−1.751	−1.181	−2.224
Total investments	0.473	0.003	6.788	2.737	2.005	2.583	21.523	13.898	30.791

Notes: 1. The relevant instrument variables are valued in 1978 billion TL.
2. Shock legend: 1=increase in world price of intermediate goods imports.
2=decrease in foreign capital inflow.
3=decrease in rate of technical productivity growth in producer manufacturing.

scheme is suggested to be multidimensional. The intermediate goods sector is observed to be the only one in which tariff protection was reduced continuously; whereas in machinery tariffs were first raised and then substantially lowered. A similar pattern of tariff administration can also be observed with respect to agricultural imports.

Overall, tariff protection is observed to depend on the nature of the shocks. For example, in the initial period, food processing confronted the "productivity" shock with increased tariff protection while tariffs in that sector were reduced in response to other types of shocks. In contrast, for textiles tariffs were raised through the entire period, except for the productivity shock of the initial stage.

As mentioned above, the Turkish mode of tariff protection under the structural adjustment program was implemented more gradually. Major reductions in quantitative restrictions and tariffs occurred only in late 1983, while at the same time compulsory fund surcharges were being raised on selective imports. Thus, Turkey seemed to switch from quota protection to implicit-tariff protection with more reliance on tariff-like surcharges.[7] Based on this history of events, it is very hard to make generalizations regarding the optimality of Turkish tariff protection as it evolved during the early eighties.

As for export promotion, we first note that there is a clear suggestion for decreasing the level of export subsidies to agriculture and directing them in favor of manufacturing. The sizes of the negative elasticity values, in fact, may be taken as suggesting the taxation of agricultural exports. This result may as well be interpreted as strong evidence of the need for transforming the composition of merchandise exports in favor of manufacturing industries, one of the main targets of the plan.

Thus, the official Turkish stance of subsidizing manufacturing exports to increase their share of total exports may be regarded as a correct decision in this respect. Within the manufacturing sector, however, the export subsidization program has displayed great variety. For instance, in the textiles and machinery sectors, export subsidies were reduced with respect to "foreign trade" shocks and were increased in response to the "productivity" shock. More interestingly, the N matrix of optimal export policy rules did not indicate textiles as the leading export sector to be promoted.

It can be further observed that, for producer manufacturing, subsidies were generally raised in the first half of the period and then lowered in the final period. This can also be interpreted as suggesting an "infant-export-industry promotion" program with respect to subsidization of producer manufacturing exports. Based on these observations, one can argue that, when contrasted with the historical evolution of export promotion in Turkey, tht use of subsidies for promoting exports was too prolonged and over intensive to be regarded as optimal.

The optimal policy adjustment rules of the *initial* period indicate a need for increasing the level of aggregate fixed investments against the "productivity" shock and suggest maintenance of the planned investment rates vis-à-vis the trade shocks.

[7] For a more detailed investigation of the use of tariff and tariff-like instruments over this period, see [33].

With respect to manufacturing, in the first two periods, optimal investment allocation rules with respect to the manufacturing sector are observed to be multifaceted (shock-dependent); and furthermore, there is a clear indication that public investments are to be recovered in all of the manufacturing industries in the final period.

This mode of adjustment suggests that the Turkish investment program under structural adjustment based on reduction of capital investment was far from being optimal. Further, the realized pattern of allocation of investment funds away from industry toward services conflicted with the optimal allocation rules. In fact, the sectoral investment allocations program had already come under heavy criticisms in Turkish development policy literature, the main argument being that the allocation of investable funds away from manufacturing was in conflict with the foundations of the overall adjustment strategy based on increased manufacturing exports [34] [43].

The analysis of the N matrices further reveals that the answer to the question: "which of the typified shocks requires the most intensive adjustment?" is also sector and period specific. In general, the shock to foreign capital inflows (shock 2) is observed to require relatively "less" intense adjustment; and that the shock to the rates of technological growth coefficients warrants the most intensive modes of adjustment policies.

In concluding, one can find no support for an unambiguous, uniform set of commercial policy adjustment rules as advocated by classic liberalization orthodoxy. The underlying methodology suggests that the optimal policy responses vary by sectors, by period, and by the nature of the shock even under a given objective and that unidimensional adjustment rules may produce non-optimal outcomes.

D. *Performance of the Economy under Optimal Policy Adjustment*

The P matrices of optimal "state" variable adjustments are shown in Table IV. This table gives the paths of optimal induced deviations of the "state" variables, in the sense that their divergence from the plan's targets are minimal. The P matrices reveal how the shocks are confronted by the domestic economy and how the burden of adjustment is shared across sectors and other economic indicators.

Overall, one can read from the P matrix that the economy moved in the "right" direction. Both consumer and producer manufacturing exports rose and the trade deficit narrowed. The output performance of the individual sectors varied in response to each shock. Intermediates registered higher growth initially, but then tended to stabilize on the negative side. Per contrast, machinery lagged behind in the period of the shock, but then experienced recovering growth rates in the latter periods.

Finally, it is also worth emphasizing that the path of manufacturing wages continually fell short of the "planned" path under optimal adjustment. It nevertheless tended to *stabilize* as the adjustment elasticities diminished in absolute value over the analyzed time-horizon, indicating a possibility that both the export and growth targets could have been simultaneously attained without prolonged strain on the domestic economy and individual welfare.

TABLE IV

CONTROL WEIGHTS AND OPTIMAL ADJUSTMENT TO THE 1979 SHOCK

	Control Weights	1979			1981			1983		
		$P(i, 1)$	$P(i, 2)$	$P(i, 3)$	$P(i, 1)$	$P(i, 2)$	$P(i, 3)$	$P(i, 1)$	$P(i, 2)$	$P(i, 3)$
Real output supplies										
Agriculture	0.129	7.079	4.419	10.977	5.078	3.217	7.609	1.037	0.659	1.539
Food processing	0.049	2.272	1.411	3.565	−3.751	−2.366	−5.684	4.339	2.769	6.393
Textiles, clothing	0.031	−13.371	−8.442	−20.197	5.526	3.486	8.371	−10.063	−6.432	−14.772
Intermediates	0.082	3.263	2.062	4.921	−4.274	−2.704	−6.425	−3.489	−2.199	−5.287
Machinery	0.042	−0.462	−0.287	−0.731	0.994	0.627	1.508	1.761	1.109	2.675
Services	0.246	−1.941	−1.213	−3.003	0.893	0.568	1.324	0.167	0.112	0.214
Physical capital stocks										
Agriculture	0.087	−0.012	−0.008	−0.017	0.101	0.064	0.153	−0.276	0.173	−0.424
Food processing	0.094	2.433	1.503	3.859	−3.189	−2.011	−4.834	−12.105	−7.685	−18.052
Textiles, clothing	0.028	0.367	0.217	0.636	−3.571	−2.25	−5.417	8.098	5.182	11.851
Intermediates	0.046	13.074	8.261	19.723	5.906	3.713	9.018	6.058	3.791	9.346
Machinery	0.064	0.335	0.211	0.507	3.465	2.178	5.291	10.204	6.449	15.383
Services	0.102	−12.765	−8.078	−19.184	7.311	4.573	11.287	2.251	1.421	3.397
Average manufacturing wages	0.111	−1.156	−0.717	−1.823	−3.081	−1.941	−4.671	−0.044	−0.065	−0.622
Real private consumption	0.321	2.082	1.325	3.084	1.206	0.779	1.718	−0.681	−0.434	−1.006
Consumer manufacturing exports	0.166	2.002	1.239	3.162	4.482	2.825	6.801	2.671	1.677	4.086
Producer manufacturing exports	0.201	4.183	2.622	6.426	1.694	1.075	2.532	4.242	2.683	6.381
Trade deficit	0.201	−1.414	−0.896	−2.116	−7.875	−4.974	−11.886	−5.972	−3.784	−8.947

Notes: 1. The relevant variables are valued in 1978 billion TL.
2. Shock legend: the same as Table III.

V. DISCUSSION

In this paper we have tried to outline an analytical methodology to obtain the basic elements of a "growth-oriented" adjustment program. Combining the objectives of stabilization and growth, we have devised the optimal policy responses with respect to major instruments, and tried to stabilize the economy around a (officially) targeted path for the main economic variables.

One can, in general, infer from the results displayed in Table IV, that Turkey could have confronted the 1979 shock and the hostile environment of the eighties by an appropriate mix of trade and investment incentives that would have achieved a growth-oriented mode of adjustment. The elements of such a strategy have been much debated and sketched out in the Turkish context. Boratav [6], for example, argued that due to the presence of large-scale excess capacities in manufacturing, Turkey could have escaped the dilemma of allocating her output to the domestic or the external markets by a selective, infant-export-industry promotion scheme. Yeldan [44], on the other hand, asserts that an "integrated" industrialization strategy, based on the maximization of the agriculture-industry interlinkages of both intermediate input and final demand, would result in outcomes superior to those of balance of payments stabilization via export-led growth. Accordingly, by simultaneously increasing the rate of investment and production in wage goods (agriculture) and in key linkage-manufactures (intermediates), the economy itself might create an effective demand for the domestic absorption of these goods. This type of "agricultural demand-led industrialization" strategy has also been suggested for other countries, e.g., by Adelman [3], for Republic of Korea; de Janvry [11], for Latin America; and Mellor [27], for India.

The Turkish mode of structural adjustment has typically relied on orthodox policies of expenditure and monetary restraint, and expenditure reswitching. From a growth-oriented objective, however, the limits of such stabilization based on tax incentives and wage controls seem to have been reached.[8] The recent boom and bust growth cycle in manufacturing is seen by many students of the Turkish economy as a signal that unless productive investments in the key manufacturing industries are enacted and growth is revitalized, Turkey will not be able to meet the objectives of achieving its historical growth rates, of maintaining a rapid and sustained export performance, and of building a modern industrial base. The strategy of adjustment around the growth and capital accumulation targets, as discussed in this article, offers a plausible alternative to meet these objectives in the medium term.

[8] Türel [35] in fact argues that the Turkish economy has not yet pulled itself out of the prolonged crisis, but that the nature of the crisis itself has changed; that in the late seventies it was a crisis of balance of payments or one of "inability to earn foreign exchange," but in the late eighties it developed into one of "inability to produce on a sustained basis."

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APPENDIX: THE CGE MODEL

Analytically, we will characterize the state of the economy, equation (1), using a computable general equilibrium model. In general terms, a CGE model is composed of a system of strongly nonlinear simultaneous equations which attempt to portray algebraically the Walrasian general equilibrium transactions of a market economy. Utilizing standard numerical solution techniques based on the derivates of the excess demand functions,[a] the model effectively simulates the optimizing behavior of the economic agents in response to various market signals.

The model has a block-recursive structure, in which numerical solution techniques are employed within each block of periods (the static stage) to solve for a set of equilibrium prices and wages to clear both the product and factor markets. During between-periods (the dynamic stage), a series of sub-models allow for capital accumulation, for population growth, for changes in technical productivity, and for rural-urban migration in response to the expected rural-urban wage differentials. The model is built around a 1978 social accounting matrix which distinguishes seven sectors, four types of labor, three types of households, and a government.

The production technology in each sector is characterized by a multi-level CES function. Different types of labor categories are combined by a Cobb-Douglas specification to obtain a sectoral labor aggregate. This, in turn, is aggregated with capital to derive the sectoral value added using a CES function which allows for limited substitutability. Intermediate inputs are assumed to be demanded given the Leontieff type fixed input-output coefficients. Sectoral physical capital stocks are regarded as a heterogeneous entity, made up of fixed capital composition coefficients. Capital, once installed, is regarded immobile and the sectoral profit rates are thus allowed to vary in static equilibrium. The realized divergence across the profit rates are further utilized in a between-period, dynamic stage sub-model to revise the rules of sectoral allocation of investment for the future periods.

In agriculture, output is produced by employing agricultural labor only whose wage rate is endogenously determined given its fixed supply. In the manufacturing sectors, output is produced by employing the urban-skilled and urban-unskilled categories of labor. The real wage rate of the skilled labor type is considered socially given and is only parametrically varied. Following [13] the excess supply of skilled labor is absorbed by the unorganized, unskilled labor market, in which the wage rate adjusts freely to clear the urban factor markets. The services sectors employ all three types of urban labor and the service-labor wage rate is determined competitively.

On the trade side, the model keeps the Armingtonian composite commodity specification in which domestic goods and imports are regarded as imperfect substitutes and are aggregated along a CES function with a given elasticity of

[a] In solving the model equations, the General Algebraic Modeling System (GAMS) optimization package is used.

APPENDIX TABLE

ARGUMENTS OF THE TRADE AND PRODUCTION FUNCTIONS (1978)

	RMD	SIGC	REX	SIGT	ELAS	RSO	SIGD	SKAP
Agriculture	0.3	1.8	6.8	1.5	3.0	18.4	1.2	38.9
Food processing	1.0	1.2	5.0	1.2	2.0	12.6	0.4	72.0
Textiles, clothing	1.9	1.2	8.5	1.2	1.5	4.7	0.4	34.5
Intermediates	32.9	0.6	2.1	0.8	1.5	16.2	0.4	57.2
Capital goods	33.9	0.4	0.5	0.6	1.2	7.3	0.4	60.0
Public services[a]	—	—	—	—	—	17.4	0.4	54.6
Commercial services	2.5	0.6	3.8	0.7	1.2	23.4	0.4	50.0

Notes: RMD: ratio of imports to domestically produced goods used in domestic consumption (per cent).
SIGC: elasticity of substitution in the Armingtonian composite good aggregation.
REX: ratio of exports to gross output (per cent).
SIGT: elasticity of transformation in the CET frontier.
ELAS: elasticity of world export demand.
RSO: share of sectoral output in the aggregate (per cent).
SIGD: elasticity of substitution between aggregate labor and capital in the CES production function.
SKAP: share of capital in value added (per cent).

[a] Non-traded.

substitution.[b] Export supplies are determined on the basis of profit maximizing behavior of the domestic producers. Accordingly, domestic output is allocated to the foreign and domestic markets along a constant elasticity of transformation (CET) frontier,[c] given their relative prices. Given the separately specified world export demand functions for Turkish products, the dollar prices of Turkish exports are determined endogenously as a function of domestic production costs, exchange rate, and direct export subsidies.

The model is calibrated on the import side based on the levels of desired imports for each sector, given the Lewis and Urata [24] estimate for the import rationing factor. The assumed values of various elasticities of the trade and production functions are further exhibited in Appendix Table.

In the product markets, private consumption behavior is described by a linear expenditure system (LES) without subsistence minima. Public consumption at the sectoral level is determined by fixed share parameters. Among many alternatives available, the model adopts the "neutral" closure rule as described in [14]. Accordingly, aggregate investment as a share of GDP is fixed exogenously (at the rate projected in the Fourth Plan document) and household saving rates adjust freely to close the savings investment gap. Finally, the price system is normalized around an aggregate index of producer prices using the sectoral output shares as weights.

[b] See [14, Chapter 7] for a more detailed discussion of the composite commodity system in a CGE framework.

[c] For a detailed discussion of the theory and use of the constant elasticity of transformation frontier in the CGE framework, see [12].