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Bulletin Number 98-1

January 1998

**ECONOMIC DEVELOPMENT CENTER**



**HOW FISCAL (MIS)-MANAGEMENT MAY IMPEDE TRADE REFORM:  
Lessons From An Intertemporal, Multi-Sector General  
Equilibrium Model for Turkey**

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# HOW FISCAL (MIS)-MANAGEMENT MAY IMPEDE TRADE REFORM:

## Lessons From An Intertemporal, Multi-Sector General Equilibrium Model for Turkey

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October, 1997

### **Abstract**

We utilize a multi-sector general equilibrium model based on intertemporally optimizing agents to study issues of trade liberalization and fiscal adjustments in the context of the Turkish economy. A key feature of the model is its explicit recognition of the distortionary consequences of excessive borrowing requirements of the public sector through increased domestic interest costs. The model results suggest that the postponement of adjustment to growing public debt and fiscal imbalances could be detrimental; and that in the absence of coordinated fiscal reforms, the welfare gains expected from trade liberalization may significantly be negated.

**JEL Classification:** C68, D58, E62, F11, H63, O41, O53

**Key Words:** intertemporal general equilibrium, trade liberalization, fiscal economics, debt management, Turkey

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## HOW FISCAL (MIS)-MANAGEMENT MAY IMPEDE TRADE REFORM:

### Lessons From An Intertemporal, Multi-Sector General Equilibrium Model for Turkey<sup>1</sup>

#### I. Introduction

The decades of the 1980's and 1990's have been a period of transition and adjustment for many developing countries. The transition, in various degrees and stages, entailed elimination of the quantitative barriers to trade, relaxation of foreign exchange controls, liberalization of capital markets, and fiscal reforms that seek to balance revenues with expenditures. However, many countries found some reforms far easier to implement than others, and had difficulty in sequencing the various stages of reform, while others tended to stall and not fully complete the reform process. Indeed, a common concern for many *Newly Industrializing Countries* (NICs) and the so-called *Economies in Transition* has focused on how to implement fiscal adjustments necessitated by the loss of revenues from trade and capital market reforms.

A typical consequence of ill-coordinated reform is a rise in fiscal deficits that must then be financed by real transfers in one form or another. Policies to finance the deficit from domestic and foreign savings have become more common than seigniorage extraction from monetization. Nevertheless, as recent experiences of Mexico and several Asian countries show, these policies tend to crowd out private sector investment, causing savers, both domestic and foreign, to channel funds to the financing of government deficits rather than capital formation (see, e.g. Blejer and Cheasty, 1989; and the surveys in Caprio, Atiyas and Hanson, 1996). As the ratio of the public debt to national income rises, numerous uncertainties surface, such as whether the reforms can be carried to fruition, or whether the distortions caused by deficit financing might deplete the efficiency gains sought by opening goods markets to the world economy.

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<sup>1</sup> A previous version of the paper was presented at the First METU Conference on Economics, 17-20 September, Ankara. We wish to acknowledge our indebtedness to Jean Mercenier, Agapi Somwaru and to colleagues at METU, Bilkent, and Minnesota for their suggestions and critical comments.

For these and many other reasons, governments must often pay a risk premium above international market rates to clear domestic markets for public debt instruments.<sup>2</sup>

Lessons derived from many of the liberalization episodes of the 1980's and 1990's suggest that the uncoordinated and ad hoc policies to close the "external" and the "fiscal" gaps (Bacha, 1990), in most cases, increased the fragility of the newly developing domestic asset markets vis-à-vis the international markets. In the absence of a coherent set of policies to restore the macro fundamentals, the potential volatility of the domestic rate of interest along with the induced swings of capital in/out-flows become an important source of macro disequilibria.<sup>3</sup>

In this paper, we develop an intertemporal, multi-sector (GE) model to analyze the nexus of these issues. We focus on the effects of rising fiscal debts and trade liberalization on foreign trade, capital accumulation and transitional (medium-run) growth in the context of Turkey's post 1990 experience with this problem. The prevalence and nature of the problems that the countries are likely to encounter when trade reforms are not accompanied by broader based fiscal reforms are briefly discussed in the next section. Then, in the context of this broader problem, the case of Turkey is investigated more closely. This investigation provides the context for the model specified in Section III and the empirical analysis then follows. A special and unique feature of the modeling analysis is the specification of capital markets in a manner that accounts for the level of risk premia apparent in the data. The policy simulations and results are discussed in section IV. The results suggest that imbalances in the government fiscal accounts cause a contraction of sectoral outputs and real GDP beyond the levels expected from trade liberalization. The simulation results show clearly that the longer the delay in making the necessary adjustments toward sustainable fiscal targets, the larger will be the gap between gains from "coordinated" liberalization and the "ad hoc" liberalization attempts which are accompanied by accumulation of domestic debt.

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<sup>2</sup> This rise in the domestic rate of interest, in many instances, could also be the result of a discretionary policy towards liberalizing the capital account. Under conditions of an open domestic capital market facing international competition, authorities themselves may choose to use the interest rate as a tool to prevent *currency substitution* –the case where the economic agents may wish to satisfy their demand for monetary services by holding foreign-denominated currency or deposits, rather than the domestic assets (Tanzi and Blejer, 1982; Girton and Roper, 1981; Miles, 1978). In addition, high interest rates could as well be taken as part of an investment finance policy to induce the desired level of capital inflows. See, e.g., the UNCTAD Trade and Development Report, 1995 for a broad coverage of these issues and recent country experiences.

<sup>3</sup> See, e.g., the country analyses of Diaz-Alejandro (1985); McKinnon (1982); Tanzi and Blejer (1982); Gibson and Tsakalatos (1994) ; Fanelli et.al. (1996); and Calvo et. al. (1996).

While the model is structured to characterize these disequilibria as a property of the transition path, in a real economy, these disequilibria may continue indefinitely as the country oscillates from crisis to crisis.

## **II. Dilemmas of Trade Reform**

### **II.1 The Prevalence of the Problem**

The salient features of the problems encountered with ill-coordinated trade liberalization experiences can be seen from the data on fiscal balances and external debt indicators of selected low- and middle-income developing countries (Table 1).

<insert Table 1 approximately here>

Note at the outset that, despite extensive efforts towards trade liberalization, taxes on foreign trade still claim the bulk of aggregate fiscal revenues in many countries.<sup>4</sup> This is particularly true for the low-income tier, especially sub-Saharan Africa. Countries like Ghana, Lesotho and Rwanda are observed to generate at least a third of their aggregate current revenues out of taxes on foreign trade transactions. Many low-income Asian countries, such as Pakistan, India, Nepal or Philippines, tend to share this feature, as well. Among the lower-middle income countries, e.g., Bolivia, Cameroon, and Peru, revenues from foreign trade are almost equal to revenues from personal and corporate income. For the upper-middle income tier, revenues from foreign trade are of lesser importance; nevertheless, cases exist here too where trade tax revenues exceed 10% of the aggregate fiscal revenues.

Overall, these observations reveal the reluctance of many governments to liberalize foreign trade while also broadening the tax base. In fact, another observation pertains to the rather lax level of the aggregate current revenues of the governments in the first place. Notwithstanding the important exceptions such as Egypt (34.3%), Bulgaria (35.6%), Tunisia (29.9%) and Portugal (34.3%), many countries covered in Table 1 reported total fiscal revenues less than 20% of their respective national incomes. This highlights the severity of fiscal constraints to pursuing trade reform without broadening the tax base. That fiscal balances are in erosion in most of the reported set of countries is also shown in Table 1. Fiscal deficits, as a ratio of GNP, are high, not only

Table 1. Fiscal Balances, Terms of External Borrowing in Selected Developing Countries, 1993

	As % of Central Government Current Revenues	Taxes on international trade and transactions	Total Central Gov. Current Revenues (As % of GNP)	Central Government Surplus/Deficit (As % of GNP)	Current Account Balance (As % of GDP)	Total Debt Service (As % of Exports)	Interest Payments on External Debt (As % of Exports)
Bolivia	6.0	7.1	15.6	-2.1	-12.9	59.4	16.0
Brazil	16.5	1.7	26.6	-1.0	-0.1	24.4	9.2
Bulgaria	12.7	9.1	35.6	-12.9	-5.0	5.6	4.8
Cameroon	19.9	19.6	16.3	-2.0	-7.2	20.3	8.1
Chad	22.6	15.3	9.1	-7.5	-23.3	7.2	5.0
Chile	19.3	9.9	24.4	2.1	-5.5	23.4	9.4
China	36.9	16.9	5.2	-2.3	-2.8	11.1	3.7
Egypt, Arab Rep.	22.0	10.9	38.7	-4.1	0.6	14.9	8.3
Ghana	16.8	26.8	16.9	-2.5	-13.6	22.8	9.0
Greece	29.8	0.1	24.3	-15.6	-7.6		
Guinea	14.6	47.5	14.0	-3.3	-2.1	9.5	4.5
India	18.7	24.9	14.4	-4.8	-0.3	28.0	14.8
Kenya	29.6	10.6	22.5	-3.8	1.3	28.0	11.3
Korea, Rep.	31.4	5.8	18.9	0.6	0.2	9.2	2.9
Lesotho	16.9	51.8	27.1	-0.3	-61.7	5.1	1.9
Malaysia	34.5	13.8	28.7	1.7	-3.3	7.9	2.4
Nepal	9.9	30.8	9.6	-6.3	-7.4	9.0	3.6
Nicaragua	11.3	21.1	29.8	0.5	-47.4	29.1	15.9
Pakistan	13.9	26.3	18.4	-7.4	-8.0	24.7	10.6
Peru	18.3	11.0	10.8	-1.8	-5.4	58.7	23.8
Philippines	29.1	30.1	17.1	-1.5	-6.6	24.9	10.5
Portugal	26.2	0.3	34.3	-2.2	-2.2	19.3	7.8
Rwanda	15.6	31.1	13.2	-9.1	-26.5	5.0	2.8
Thailand	27.9	18.2	18.3	2.1	-5.6	18.7	5.8
Tunisia	12.6	28.5	29.9	-2.6	-8.0	20.6	7.7
Turkey	35.6	4.3	18.7	-7.0	-4.5	28.3	13.1
Uruguay	6.9	7.1	29.9	0.6	-1.9	27.7	16.5
Venezuela	51.8	10.5	18.0	-3.0	-3.7	22.8	12.5
Zimbabwe	44.4	19.0	31.8	-7.0	-5.9	31.1	10.5

Source: World Bank Development Report, 1996.

in the transition economies such as Bulgaria (12.9%), Romania (4.7%) and the Slovak Republic (4.8%), but also in many market economies, such as Greece (15.5%), Turkey (7.0%), Pakistan (7.4%) and Egypt (4.1%).

The severity of the fiscal constraint together with the current account balance is regarded as one of the major indicators of the external fragility of a country, signaling the associated risk. The fifth column of Table 1 documents the relevant data. Countries that suffer from the fiscal imbalances are observed to be closely associated with worsening current account positions. A culmination of these imbalances is that economies are in an adverse position for attracting foreign funds. Such economies must often offer interest rates in excess of the world market rates in order to attract foreign capital, the differential being largely accounted by a risk premium. Figure 1 offers an illustration of this, where the cluster of countries with highly negative fiscal balances and high interest costs of external public debt are clearly visible.

<insert Figure 1 approximately here>

The overall picture portrayed in Table 1 and Figure 1 thus underscores the problem of carrying reform to fruition, as a large number of countries are having difficulties in balancing their fiscal accounts in the course of liberalization imperatives. The post-1990 experience of the Turkish government's attempt to liberalize trade, its failure to broaden the tax base, and then its attempts to form a customs union with the European Union (EU) in the presence of faltering fiscal balances and severe macro disequilibria serve as an outstanding example of this problem.<sup>5</sup>

## II.2 The Turkish Case

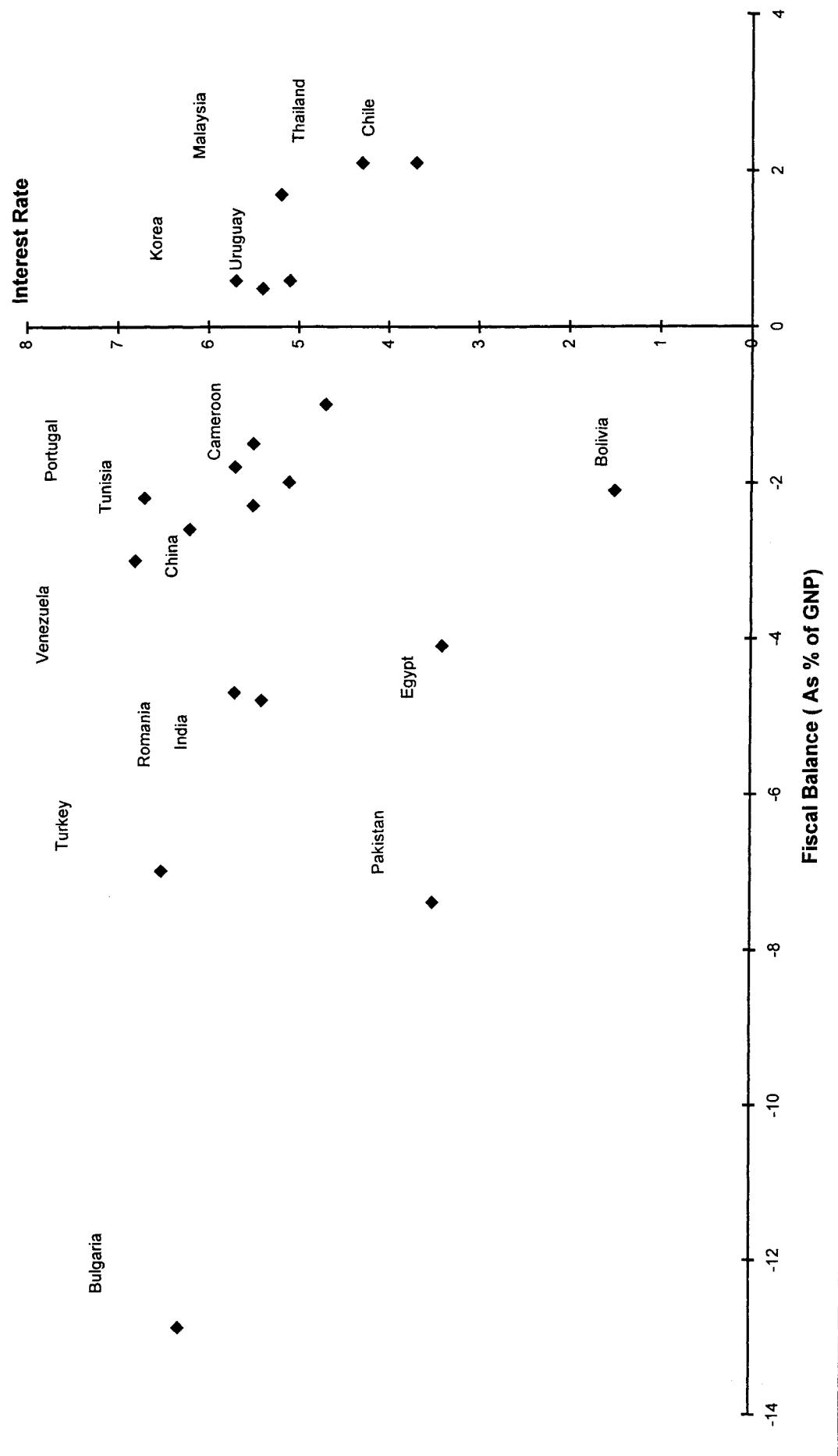
The rapid deterioration of Turkey's fiscal position during the early 1990s is well documented. (Sak, Özatay, and Özturk, 1996; Atiyas, 1995; Boratav, Türel and Yeldan,

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<sup>4</sup> We observe in the World Bank data set that out of 47 low/middle-income developing countries for which data exists for both the income and trade taxation, 24 had trade tax revenues exceeding the total revenues from taxes on incomes and capital gains.

<sup>5</sup> See Mercenier and Yeldan (1997) for an intertemporal general equilibrium analysis of Turkey's recent move to trade integrate under a customs union with the EU. Yeldan (1997b) also offers a general equilibrium analysis of the political economy factors behind the prolonged instability of the Turkish macro environment in the 1990's.

**Figure 1. Fiscal Gap and Average Interest Rate on External Public Debt**



1996; and Önder et.al.,1993). The major breakdown occurred in the flow of factor revenues generated by the state economic enterprise system, and by the rapid rise in transfer payments. The aggregate disposable income of the public sector fell by 30% in real terms between 1988-1995 and the public saving-investment gap widened by almost 4-folds. The rise in transfers was largely caused by political pressures associated with the elections of 1989 and 1990. As a ratio of GNP, transfers rose from 6.1% in 1991, to 12.0% in 1994. Likewise, the saving generation capacity of the public sector eroded severely and turned negative after 1992.

In the presence of these difficulties, Turkey pursued efforts to form a customs union with the European Union (EU) in 1995. The government agreed to harmonize its tariff regime, which resulted in further revenue losses from trade taxes. The loss of these revenues placed additional strains on the fiscal balances. Harrison, Rutherford and Tarr's (1996) estimate that value added taxes must be increased by 16.2% in order to compensate for this loss of revenue. Köse and Yeldan (1995) incorporated oligopolistic mark-up pricing in a static CGE of 26 sectors, and found the necessary indirect tax adjustment to reach 36%. The loss of tariff revenues occurred at a time when fiscal authorities realized that continued seignorage extraction through monetization was no longer feasible; that is, the Treasury had almost fully exploited the Laffer curve (Yeldan, 1997a; Selcuk, 1996). Thus, these developments led to a sharp increase in the public sector borrowing requirement (PSBR) which rose to 11.7% of the GNP in 1993, and then leveled off to about 7% thereafter. Since external sources of public sector finance were extremely limited<sup>6</sup>, the state was forced to resort to massive domestic debt financing by issuing new debt instruments (bonds), part of which were needed to service the existing debt.

These instruments dominated the financial markets almost exclusively. In 1995, the share of new issues of public securities in total securities issued stood at 90%; and the share of public assets in the secondary market reached to 95% (Balkan and Yeldan, 1996). For bond markets to clear at rising volumes, higher real rates of interest had to be paid. Rising rates presumably reflected not only the rising opportunity cost of savings but also a risk premia. These factors combined led to excessively high interest rates, crowding out private investment.

Under these conditions, the stock of domestic debt grew rapidly, reaching 20% of the GNP by the end of 1995. A critical feature of debt accumulation was its extreme short-term maturity. By 1992, the state was already trapped in a *Ponzi-style* finance of its debt, with net new government borrowings reaching to 92% of the domestic debt outstanding. By 1995, this ratio accelerated to 132%. Thus, “management” of the domestic debt and the increase in the fiscal gap emerged as an issue of paramount importance for Turkish policy-makers in the second half of the 1990’s.

The following pages of the paper analyses these issues within the context of laboratory experiments of an inter-temporal GE model that is specified in the next section.

### III. The Model

With some modification, the model utilized in this section is an extended neoclassical intertemporal general equilibrium model with a government whose purpose is to collect taxes, administer expenditures and issue debt instruments. The model draws upon the recent contributions on intertemporal GE modeling by Wilcoxen (1988), Ho (1989), Goulder and Summers (1989), Mercenier and de Souza (1994), and Diao and Somwaru (1997). Data used to calibrate the model parameters and to conduct our simulation experiments are drawn from Köse and Yeldan (1996), the recent Input-Output Table of Turkey (SIS, 1994), and other sources to represent the macro equilibrium of the Turkish economy in 1990. We aggregate production activities into six production sectors (agriculture, consumer manufacturing, producer manufacturing, intermediates, private services, and public services), employing labor and capital to produce the respective single outputs. With fixed supply<sup>7</sup>, labor is mobile across sectors (but not mobile internationally). Capital, on the other hand, is sector-specific, and is accumulated over time. Technological change is assumed not to be influenced by the policies considered in the paper, and hence is ignored.

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<sup>6</sup> Net foreign borrowing of the government during 1989-1997 was almost negative, and in those years when the public sector experienced *net inflows*, their amount barely reached to 1 percent of the GNP (Yeldan, 1997b).

<sup>7</sup> This specification has no real effects on the model since, alternatively, we could normalize all variables in per capita terms.

*III-1 The Household and Consumption/Savings.* The representative household owns labor and all private financial wealth, and allocates income to consumption and savings to maximize an intertemporal utility function over an infinite horizon:

$$(1) \quad \text{Max } U_1 = \sum_{t=1}^{\infty} \left( \frac{1}{1+\rho} \right)^t \frac{\left( \prod_i c_{i,t}^{\alpha_i} \right)^{1-\theta} - 1}{1-\theta},$$

subject to the intertemporal wealth constraint:

$$(2) \quad \sum_{t=1}^{\infty} R_t \left( \sum_i p_{i,t} c_{i,t} \right) = TW_1$$

where  $\rho$  is the positive rate of time preference;  $\theta$  is inverse of the intertemporal elasticity of substitution;  $c_{it}$  is household demand for each of the six goods;  $0 < \alpha_i < 1$ , and  $\sum \alpha_i = 1$ ;  $p_{i,t}$  is the price for good  $i$ ,  $TW_1$  is the initial private wealth, and  $R_t$  is a discount factor defined as:

$$(3) \quad R_t = \prod_{s=1}^t \frac{1}{(1+r_s)}$$

and  $r_s$  is the interest rate. The household budget constraint can also be defined in terms of current income and expenditure flows, i.e., in each period, the household earns incomes from wages,  $wL$ , firm's profits,  $div$ , government transfers,  $TI$ , and interests on government and foreign bonds,  $BPG + BF$ , such that:

$$(4) \quad SAV_t + \sum_i p_{i,t} c_{i,t} = (1 - ty_t) [w_t L_t + div_t + TI_t + r_t (BPG_{t-1} + BF_{t-1})]$$

where  $SAV$  is household savings which will be invested on the purchases of government and foreign bonds or firm equities; and  $ty$  is the income tax rate.

*III-2. Firms and investment.* The representative firm in each sector carries both production and investment decisions so as to maximize the value of the firm. The intertemporal decision problem of the firm can be stated as follows: in each sector- $i$ , the firm chooses the levels of investment,  $I_{it}$ , and labor employment to maximize the

present value of all future profits, taking into account the expected future prices for sectoral outputs, the wage rate, the capital accumulation constraint and the capital adjustment cost function,  $a_{i,t} = \phi \frac{I_{i,t}^2}{K_{i,t}}$ . Specifically, the firm chooses the sequences  $\{I_{i,t} L_{i,t}\}$ ,

$$(5) \quad \text{Max } V_i = \sum_{t=1}^{\infty} R_t \text{div}_{i,t} \equiv \sum_{t=1}^{\infty} R_t \left[ PVA_{i,t} (f_i(K_{i,t}, L_{i,t}) - a_{i,t}) - w_t L_t - PI_{i,t} I_{i,t} \right]$$

subject to

$$(6) \quad K_{i,t+1} = (1 - \delta_i) K_{i,t} + I_{i,t}$$

where  $V_i$  is the current market value of firm;  $R_t$  was introduced in (4) above, and  $\delta_i$  is the sectoral depreciation rate. Because of the recognition of adjustment costs on capital, marginal products of capital differ across sectors, resulting in unequal, although optimal rates of investments. The new capital equipment,  $I$ , is produced by forgone outputs of the six sectors with a Cobb-Douglas function, and hence,  $PI_i$  can be written as a function of the final good prices. However,  $PI_i$  only represents the unit cost of the forgone outputs used to produce the new capital equipment, while the marginal value of capital (the well-known Tobin's  $q$ ) has to take into account the adjustment costs, i.e.,  $q_i = PI_i + PVA_i \frac{\partial a_i}{\partial I_i}$ .

*III-3. The Government as the Fiscal Authority.* The government has four interrelated functions in the model: collect taxes, distribute transfers payments, purchase goods and services, and administer domestic public debt.

The model distinguishes three types of tax structure. *Direct income taxes* are set at a given ratio of private income; *indirect taxes* are levied on the gross output value in each sector; and *trade taxes* are implemented ad valorem on imports. Government's basic spending includes the transfer payments to households, public consumption expenditures (inclusive of wage costs of public employees) and interest

costs on outstanding public debt. Government budget deficit may arise from the excess of aggregate expenditures over the tax income.<sup>8</sup> The fiscal deficit is financed exclusively through new issues of government bonds. Thus, government bonds issued at period  $t$  is defined as:

$$(7) \quad BPG_t - BPG_{t-1} = GDEF_t$$

and

$$(8) \quad GDEF_t = r_t BPG_{t-1} + r_t BFG_{t-1} + \sum_i P_{it} GD_{it} + TI_t - \left[ yt_t HY_t + \sum_i it_{it} PX_{it} X_{it}^S + \sum_i tm_{it} PWM_{it} M_{it} \right]$$

where  $GDEF_t$  is the government's budget deficit at time  $t$ ;  $BFG_t$  is the stock of foreign debt of the public sector;  $HY_t$  is household gross income,  $it_{it}$  is indirect tax rate for sector  $i$ ,  $PX_{it}$  is output price of good  $i$ ,  $X_{it}$  is output of good  $i$ ;  $tm_{it}$  is the tariff rate;  $PWM_{it}$  is world price for imported good  $i$ ; and  $M_{it}$  denotes imports of good  $i$ .  $P_{it}$  and  $GD_{it}$  are the price and government consumption of commodity- $i$ , respectively.

Presuming restricted foreign borrowing opportunities, the public sector's foreign debt,  $BFG$ , is assumed to remain constant at the level given by the initial data throughout the simulated policy experiments. A rise in the fiscal deficit as caused by a shock to either the government's sources of revenue or to its expenditure items are financed exclusively by new issues of public debt instruments which are purchased by the domestic households,  $BPG$ .

To avoid the difficulties that would result from modeling the government as an intertemporal optimizing agent (see Mercenier and de Souza, 1994), we assume

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<sup>8</sup> It has to be noted that, even though this formulation of the fiscal position of the government is fairly "general", there are differences of opinion on the "precise" calculation of the public sector's budget constraint. In their extensive survey on the *measurement of fiscal deficits* across countries, for instance, Blejer and Cheasty (1992: 1644) state that "from one country to the next, the considerations that need recognition in budgetary analysis ... may vary widely. Hence, the search for the single perfect deficit measure may be futile". In this study, we rely on the World Bank's (1988: 56) assessment of the deficit generating components, where "expenditure includes wages of public employees, spending on goods and fixed capital formation, interest on debt, transfers and subsidies. Revenue includes taxes, user charges, interest on public assets transfers, operating surpluses of public companies and the sales of public assets".

that the transfer payments are proportional to aggregate government revenues, while the total public consumption of goods (excluding for public services) is set as a constant share of the gross domestic product. Similarly, sectoral purchases are distributed according to fixed expenditure shares.

*III-4. The Foreign sector.* Following the traditional CGE folklore, the model incorporates the Armingtonian composite good system for the determination of imports, and the constant elasticity of transformation (CET) specification for exports. In this structure, domestically produced and foreign goods are regarded as imperfect substitutes in aggregate demand, given an elasticity of substitution/transformation. The economy is *small*, hence the world prices are regarded as given constants. However, the *composite* prices do change endogenously as domestic prices adjust to attain equilibrium in the commodity markets. The output of public services consists entirely of civil servant wages, and hence, is regarded as a (non-traded) home good with government being its sole buyer.

In each period-equilibrium, the difference between the household savings,  $SAV_t$ , and the government's borrowing requirement,  $GDEF_t$ , gives the amount of new foreign bonds held by households. The time path of private foreign assets has two components: trade surplus (deficit if negative) denoted  $FBOR_t$ , and interest income received from the accumulated foreign assets,  $r_t BF_{t-1}$ . Thus, accumulation of the private foreign assets evolve as follows:

$$(9) \quad BF_t - BF_{t-1} = r_t BF_{t-1} + FBOR_t,$$

*III-5. Equilibrium.* Intra-temporal equilibrium requires that at each time period, (i) domestic demand plus export demand for the output of each sector equal its supply; (ii) demand for labor equals its supply; and (iii) government spending equals government revenues plus new issues of public debt instruments. The inter-temporal equilibria are further constrained by the following steady state conditions:

$$(10) \quad r_{ss} V_{ss} = div_{ss}$$

$$(11) \quad I_{i,ss} = \delta_i K_{i,ss}$$

$$(12) \quad 0 = r_{ss} BF_{ss} + FBOR_{ss}$$

$$(13) \quad GDEF_{ss} = 0$$

Equation (10) implies that at the steady state, the value of the firm,  $V_{ss}$ , becomes constant and hence the profits,  $div_{i,ss}$ , is simply equal to the interest earnings from a same amount of riskless assets. Equation (11) implies that in each sector- $i$ , investments just cover the depreciation of sectoral capital; hence the stock of capital remains constant. Equation (12) states that foreign asset holding is constant. Equation (13) is the solvency (transversality) condition on government debt,<sup>9</sup> which requires that government debt has to be constant at the steady state. This implies that government has to have a surplus on its primary budget which equals its interest payments on its domestic and foreign debt.

## IV. Analysis of Alternative Policy Regimes

### IV-1. Description of the Simulation Experiments and Their Motivation

Theory suggests that, in the absence of market imperfections and/or external effects, trade liberalization increases efficiency of the economy due to re-allocation of resources among the production sectors. However, liberalization attempts also have income re-distribution consequences, especially between the public and private sectors, as government revenues from trade protection fall. This requires that liberalization episodes necessarily have to concur with a stable macroeconomic environment, especially in fiscal balances of the public sectors. In many instances, however, trade liberalization and fiscal reform are loosely coordinated, and the expected benefits from reform fail to be materialized. Persistent fiscal deficits necessitate extraction of financial funds from the capital markets which could otherwise be utilized in new capital formation. On the other hand, the ongoing rise of the borrowing requirement of the public sector generates additional pressures on the

newly developing indigenous asset markets and tends to increase uncertainty in the economy. With the increased risk and the accompanying fragility of the domestic financial markets, transactors often face higher interest costs than those that prevail in the international markets. Thus a risk premium emerges between the domestic and the international interest rates, a consequence of which is the distortion of the saving and investment decisions of the residents.

Given this background, we attempt to study analytically the resource allocation processes of trade liberalization together with the ongoing pressures of delayed/uncoordinated fiscal reform with the aid of three simulation experiments. *First*, we envisage an environment in which both the trade and the fiscal policies are perfectly coordinated. We eliminate all existing tariffs on imports, and to compensate for the losses of fiscal revenues, we endogenously adjust the income tax rate. Thus, the fiscal budget balance of the government is maintained for all time periods, and the trade reform has neutral consequences for the public sector expenditure patterns. We treat this case as the optimal benchmark and identify as EXP-1.

Under EXP-2 and EXP-3 we consider a case where reform causes losses of tax revenues but the government is reluctant to curtail its expenditures, or to introduce off-setting sources of non-distorting revenue instruments. In addition, pressures from public sectors force the government to raise public employee's wage payments. Thus, the government's budget gap is further widened. In practice, policies can seldom be perfectly coordinated due to mis-communications among various layers of the bureaucracy; pressures from the domestic interest groups which are hurt by the reform, and the like. Thus, the purpose of EXP-2 and EXP-3 is to capture such delays in accommodating the necessary policy coordinations and to trace out their consequences on the overall economy.

Under the EXP-2 policy environment, we first portray a stance of *inaction*, and delay implementation of the necessary revenue enhancing measures for 20 periods. After then, the income tax rate is endogenously adjusted so as to impose the intertemporal budget (solvency) constraint of the government.<sup>10</sup>. Under EXP-3, on

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<sup>9</sup> Since the interest payments are recorded among the current period public expenditures, this steady state condition does not involve interest costs.

<sup>10</sup> It has to be noted that our focus is mainly on the evolution of the transition path, rather than the time period when the economy has sufficiently approached the fully intertemporal equilibrium --the steady state. One has to note that the eventual attainment of the government budget balance is part of the technical constraints of intertemporal equilibrium. This implies that from the technical point of view

**Table 2. Summary of Simulation Experiments**

<b>TRADE POLICY SHOCK: <i>Eliminate all tariffs on imports</i></b>		
<b>FISCAL POLICY ALTERNATIVES FOR THE GOVERNMENT</b>		
<b>EXP-1</b>	<b>EXP-2</b>	<b>EXP-3</b>
Simultaneously adjust the income tax rates such that the government current budget constraint holds.	1. Raise public service wages and delay government income adjustment for <b>20</b> periods.	1. Raise public service wages and delay government income adjustment for <b>40</b> periods.
	2. After period 20, income tax rate adjusts endogenously to impose government's solvency constraint on its debt.	2. After period 40, income tax rate adjusts endogenously to impose government's solvency constraint on its debt.

the other hand, we worsen the fiscal stance of the government and portray a situation of *no adjustment* at all. In this setting, the income tax adjustment is delayed until period 40, which, for all practical purposes, amounts a complete paralysis of the government's ability to carry out any viable fiscal reform. Thus, with these two experiments we highlight many of the basic attributes of the Turkish reality of the 1990's with deferral of the necessary adjustments through a tax reform; heavy reliance on the domestic asset markets for financing the fiscal gap; intensified use of the politically motivated high income transfers initiated to the private sector; and diversion of the domestic rate of interest away from the return on international assets.

We summarize the salient features of each experiment in Table 2.

<insert Table 2 approximately here>

## IV-2. Policy Analysis

We document our simulation results in Tables 3 and 4, and portray the adjustment paths of selected variables in Figures 2-5. All results are reported as ratios to the base-run steady state.

<insert Table 3 approximately here>

Under scenario EXP-1, the government simultaneously adjusts the income tax rate when the tariffs are eliminated such that its budget balance is continuously maintained. This tax adjustment neutralizes the macro economic consequences of tariff liberalization, and does not involve any distortionary effect due to the celebrated *Ricardian equivalence*.<sup>11</sup>

In this first best policy environment, the intertemporal nature of our model allow us to capture both the static gains from resource reallocation, and the dynamic gains from increases in capital investment. We observe that investment is stimulated

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the government eventually has to raise taxes and/or adjust expenditures to meet the steady state equilibrium constraint on fiscal balances. The model per se cannot give us a guideline about the specific timing of the imposition of this endogenous adjustment, and one has to impose this constraint at an arbitrary point. We thus rely on the laboratory characteristics of the model to impose this constraint and endogenize the income tax rate such that the fiscal balances are met with no deficit under the steady state. Since our exclusive purpose here is to capture the effects of delayed fiscal reform, our discussion will focus on the time periods before the tax rate has been endogenized to impose this constraint.

<sup>11</sup> The Ricardian equivalence proposition is popularized by Barro (1974, 1979) and is extensively debated in the empirical literature on fiscal debt management (see, e.g., Eisner, 1989; Gramlich, 1989;

**Table 3. Dynamic Results of Alternative Policy Regimes (Ratios to Base-Run Steady State)**

	Experiment 1						Experiment 2						Experiment 3					
	Period: 1			Period: 10			Period: 30			Period: 1			Period: 10			Period: 30		
Aggregate Investment	1.079	1.081	1.133		1.045	1.066	1.128		1.033	1.027	1.011		1.002 (*)	1.015	1.011			
Aggregate Capital Stock	1.006 (*)	1.047	1.108		1.003 (*)	1.027	1.093		1.002 (*)	1.015	1.011							
Government Revenues	0.987	1.000	1.021		0.736	0.752	1.685		0.733	0.756	0.846							
Government Expenditures	0.987	1.000	1.021		1.002	1.163	1.686		0.996	1.149	1.871							
Government Domestic Borrowing	n.a.	n.a.	n.a.		16.104	24.811	0.098		15.855	23.703	61.877							
Ratio of Gov. Domestic Debt to GDP	n.a.	n.a.	n.a.		0.046(*)	0.508	1.356		0.046 (*)	0.502	2.689							
Ratio of Interest Payments on Domestic Debt to Gov Revenues	n.a.	n.a.	n.a.		0.017(*)	0.189	0.217		0.017 (*)	0.182	0.970							
Trade Deficit	1.456	1.197	0.756		0.788	0.951	1.118		0.181	0.260	1.463							
Private Foreign Borrowing	1.349	1.151	0.813		0.838	0.979	1.091		0.372	0.448	1.397							
Domestic Interest Rate	1.000 (*)	1.000	1.000		1.049 (*)	1.071	1.000		1.049 (*)	1.069	1.178							
Wage Rate	0.987	1.002	1.025		0.976	0.987	1.019		0.968	0.972	0.973							
Sectoral Outputs																		
Agriculture	0.975	0.976	0.988		0.975	0.971	0.986		0.973	0.966	0.971							
Consumer Manufacturing	0.988	1.022	1.085		0.999	1.018	1.061		1.009	1.038	1.006							
Producer Manufacturing	0.951	0.900	0.873		0.958	0.890	0.854		0.963	0.891	0.788							
Intermediates	0.968	0.946	0.945		0.975	0.938	0.928		0.978	0.942	0.873							
Commercial Services	1.022	1.076	1.128		1.018	1.061	1.123		1.016	1.046	1.070							

(\*) Period 2.

n.a. not applicable

and capital is accumulated along the transitional path (see Figure 2). This allows consumers to enjoy gains from liberalization by raising their final consumption along the whole transitional path. Yet, the increases in consumption and investment result in an expanding trade deficit and hence stimulates foreign capital inflows. As the economy specializes in producing goods over which it has a comparative advantage, its exports start to grow faster than its imports after the 18th period, thus the trade deficits start to fall thereafter. For example, the consumer manufacturing and the service sectors are observed to be the major net export sectors in Turkey. Thus, under the EXP-1 scenario, liberalization of trade leads to increased investments towards these two sectors, in comparison to those which were under higher tariff protection initially. Thus, outputs and hence exports of the consumer manufacturing goods and services grow rapidly after the returns to investment are capitalized. These observations imply that the initial increases in trade deficits do not necessarily deteriorate the economy's balance of payments in the long run if the increase in aggregate investment succeeds in raising production and exports of the sectors in which the economy has a comparative advantage.

The model solutions reveal that the steady state capital stock increases by 14.5%, and aggregate consumption by 2.2% in comparison to the pre-reform equilibrium. The expansion of aggregate capital stock enables the real gross domestic product to increase uniformly throughout the adjustment period. Valued in base-year prices, we find that the real gross domestic product is increased by 2.2% in period 10, and by 5.5% in period 30 as the economy approaches to its long run equilibrium. (Table 4).

<insert Table 4 approximately here>

We compute the social welfare gains by constructing an *equivalent variation* index which is a function of the current and future aggregate consumption, where future consumption is discounted by the discount rate of time preference. The welfare gains are summarized and contrasted with the alternative policy scenarios in Table 4. The welfare gains from the trade liberalization amount to 0.16 percent during the first 10 periods, and reaches to 0.71 percent by the end of period 30. Together with the expansion of the real gross domestic product, these gains are

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Barro, 1989; Velthoven and Veblen, 1993). An extensive critical evaluation of the Ricardian equivalence can be found in Buiter (1989), Bernheim (1989), and Bernheim and Bagwell (1988).

**Table 4. Dynamic Effects of Alternative Policy Regimes on Consumer Welfare**  
 (% Deviations from the Base-Run)

	EXP-1	EXP-2	EXP-3
<b><i>Real Gross Domestic Product</i></b>			
Period 10	2.203	1.556	1.206
Period 20	4.219	2.948	1.677
Period 30	5.518	4.760	1.532
<b><i>Change in Consumer Welfare Index(*)</i></b>			
First 10 periods	0.164	-0.616	-1.977
First 20 periods	0.457	-0.313	-2.554
First 30 periods	0.708	0.139	-2.311

(\*) Percentage Change in Equivalent Variation Index.

mainly the result of tariff liberalization under conditions of perfect policy coordination with reliance on direct income taxes as first best policy instruments.

It is clear that achieving a balance in the fiscal budget by a simultaneous tax adjustment may not be politically feasible, given the tax administration capacity of the country. Thus, next we invoke a stance of stagnation and delay the process of tax adjustment under scenarios EXP-2 and EXP-3. Furthermore, we envisage here that pressures from the public sector employees are intensified, and that the government complies with the increased wage demands of the public employees by raising their wage remunerations by 100%.<sup>12</sup>

Within the EXP-2 and EXP-3 environments, in the absence of compensating measures for generating revenue sources, a fiscal gap emerges. The government resorts to domestic borrowing, and issues debt instruments to finance its deficits. However, this added reliance on the domestic financial funds leads to a rise in uncertainty and increases fragility of the asset markets. This makes the domestic and foreign savers increasingly reluctant to be indifferent between investing in government debt instruments and other instruments offered in the domestic and the international markets at the ongoing interest rate. To depict this phenomenon, we posit a simple function that maps the ratio of the fiscal deficit to GDP into a risk premium. More formally, let  $\pi_t$  denote the risk premium over the international lending/borrowing rate; we set  $\pi_t$  as

$$(14) \quad \pi_t = \varphi \frac{GDEF_t}{GDP_t}$$

where  $\varphi$  is a shift parameter. Thus, the domestic interest rate,  $r^D_t$ , diverges from its foreign counterpart by  $\pi_t$ , i.e.,  $r^D_t = (1 + \pi_t)r^F_t$ .

We employ the simulation results of EXP-1 as the first best benchmark against which the distortionary policy environments of EXP-2 and EXP-3 are to be contrasted. With the rise of the risk premium, the fragility of the domestic asset

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<sup>12</sup> These, in fact, very much narrate the recent political-economy impasse of the Turkish government in failing to implement a coherent tax reform together with increased liabilities of transfers to the private sector, as we highlighted in Section II. The analytics of this path is discussed further below.

market is worsened, and the domestic interest rate increases by 4.9 to 7.1 percent under EXP-2, and by 4.9 to 17.8 percent under EXP-3 (Figure 3).

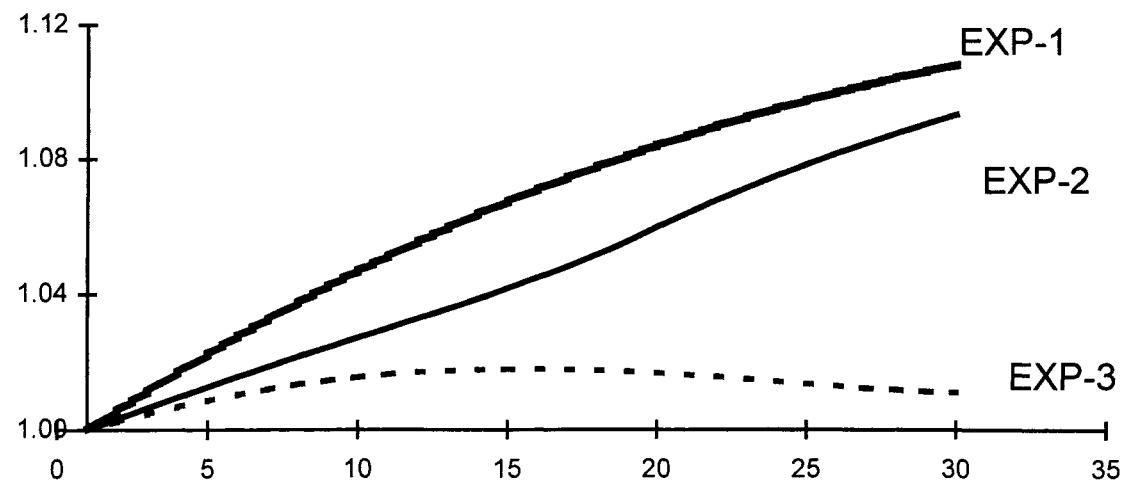
The ratio of fiscal debt to GDP accumulates rapidly as the borrowing conditions from the domestic market become more and more expensive. To pay for the high interest costs, the government has to increase its borrowing ever more. Thus, the fiscal debt accumulates at an increased speed and, for example, by period 10 its ratio to GDP reaches to 50% (Figure 4). Interest payments emerge as a major expenditure item. For the case of EXP-3, interest costs are observed to claim almost 60% of the aggregate public expenditures by period 10, necessitating the government to switch to a *short-termist* strategy of *Ponzi* style financing based on rolling of debt over time, i.e., government has to issue new bonds to pay interests on the outstanding debt, which clearly would not be sustainable neither politically, nor economically (see Figure 5).

Rise of the domestic rate of interest increases costs and reduces expected returns to investment. Hence aggregate investment falls in comparison with the EXP-1 scenario. Consequently, the aggregate capital stock converges to its steady state level from below (Figure 2); and the real gross domestic product falls short of its EXP-1 value (Table 4).

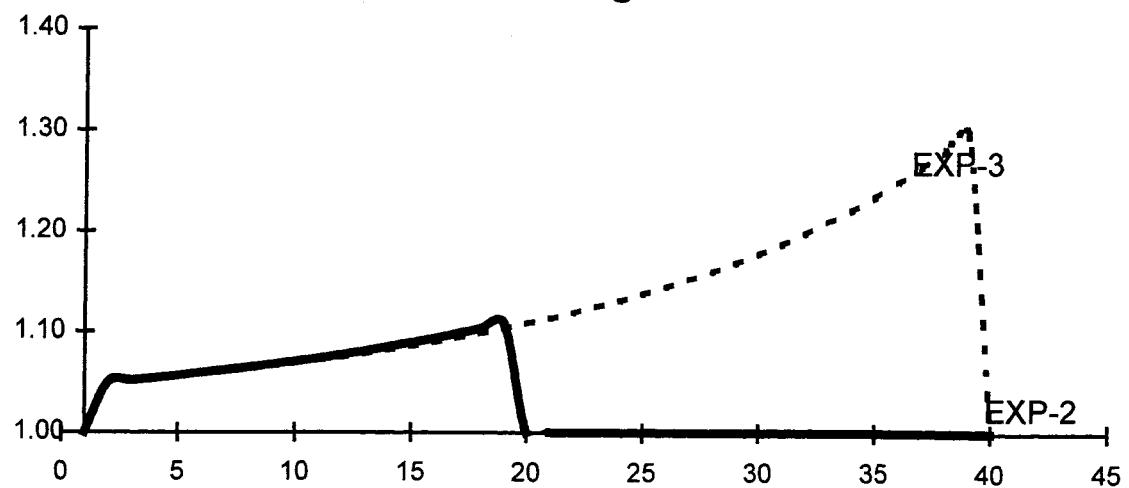
Deceleration of the investment demand and the hesitant accumulation of the physical capital stocks, together with the postponement of consumption, result in a stagnationary environment in EXP-2 and EXP-3. These factors combined lead to a fall of the welfare index from its pre-liberalization level, inhibiting part of the potential welfare gains of trade liberalization (Table 4). The adjustment path under the EXP-3 scenario portrays an even more stringent environment, and the delay of the fiscal reform coupled with the expansionary expenditure policy are observed to lead to a contractionary environment where almost all welfare gains of liberalization are negated.

It is illuminating to note that, even though the initial design of the model is not suitable for forecasting analysis, one can draw striking parallels between the historically realized development path of the Turkish economy and the results of our simulation experiments in many macro aggregates concerned, especially in the fiscal indicators. We noted above in Section II-2 that currently the ratio of the Turkish government's fiscal debt to GNP stands at about 20%, and the interest costs already

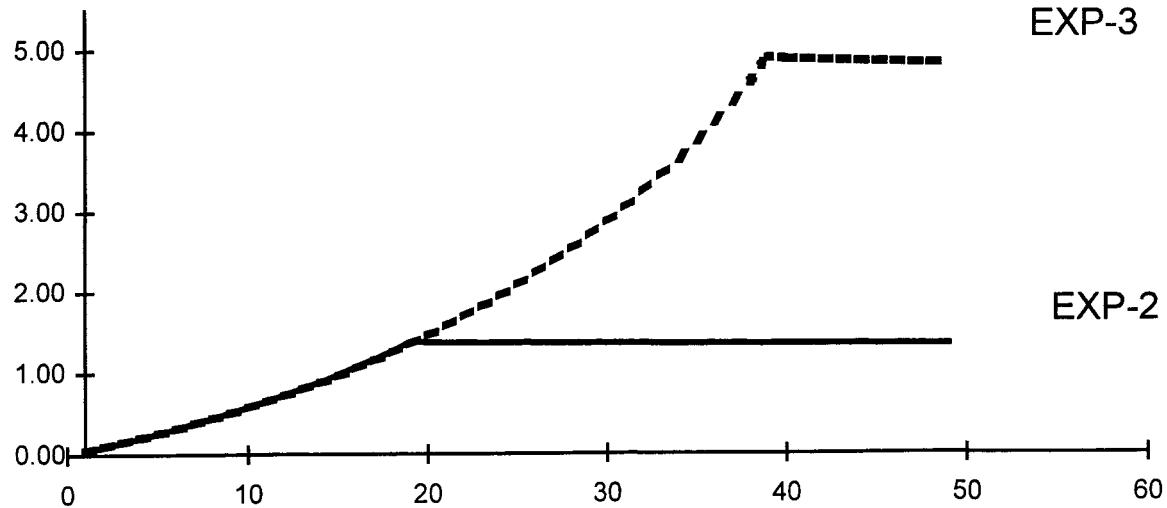
**Figure 2. Aggregate Capital Stock  
(Ratios to the Base-Run Steady State)**



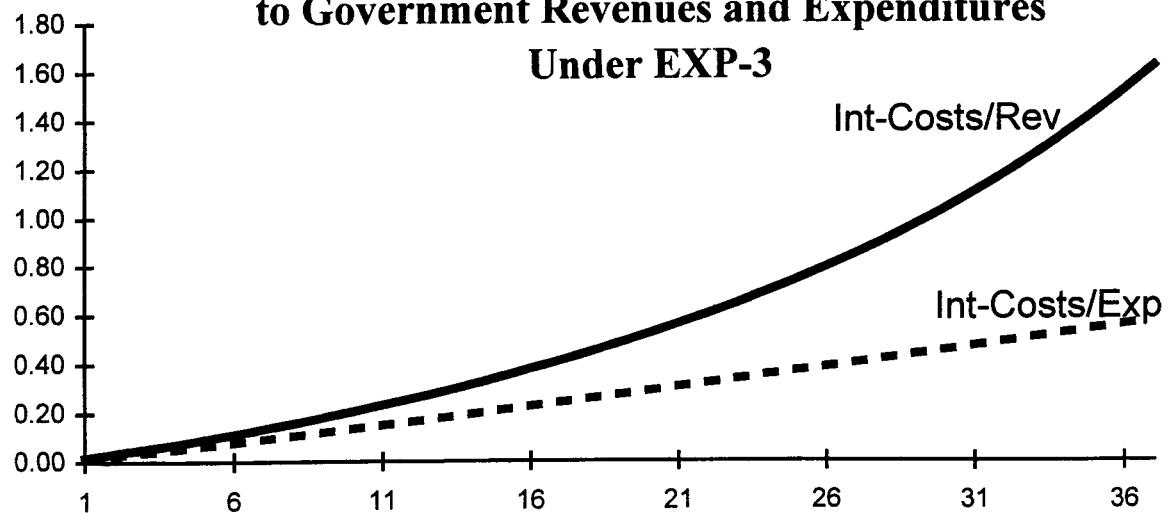
**Figure 3. Ratio of the Domestic Interest Rate  
to the Foreign Interest Rate**



**Figure 4. Ratio of Government Debt to GDP**



**Figure 5. Ratios of the Interest Costs on Public Debt  
to Government Revenues and Expenditures  
Under EXP-3**



account for about 40 percent of the total budgetary expenditures. In contrast, the ratio of fiscal debt to GNP was only 2% as recently as 1990. As documented vehemently in many recent analyses of the Turkish economy (see, e.g., Yeldan, 1997b; Boratav, Türel and Yeldan, 1996; Özatay, 1996; Sak, Özatay and Öztürk, 1996; Atiyas, 1995) the rapid deterioration of the fiscal balances clearly signals an unsustainable pattern, where the current stance of the Turkish fiscal authorities is already one of Ponzi model of debt rolling with annual net new borrowings of the public sector exceeding its existing stock of domestic debt. The short termism embedded in the maturities of the public sector assets is a significant cause for concern for the continued confidence crisis and the increased fragility (riskiness) of the domestic financial system. These elements, no doubt, lie at the heart of the reason for the presence of significantly high real rates of interest in the Turkish domestic asset markets, and are directly responsible for the invigoration of a series of adjustments which, in the technical language of our modeling analysis, lead to distortions of the investment path of the economy where expected gains of trade liberalization are exhausted. The ongoing attempts of trade reform in an environment characterized by coordination failures and unsustainable fiscal targets are clearly futile, with realized outcomes falling short of expectations of achieving a more efficient allocation of resources and of a rise in social welfare. Our results further underscore that the more delayed the necessary adjustments towards a sound fiscal reform, the higher would be the gap between such expectations and their realizations.

## V. Conclusions

Before summarizing our main findings, we feel that some caveats are in order for setting the limitations of our modeling approach. First, it has to be clear that, there can be no distinctive conclusions about the characterization of the future path of the Turkish economy based on "calendar" dates from our model. The policy experiments performed are basically of *comparative* nature and are meaningful only in relation to each other, rather than revealing forecasts of the future.

Second, we abstained from an explicit portrayal of the government's saving and investment behavior; and hence, the spillover effects of public consumption and investment on the private sector are not captured. In the absence of empirical

evidence on the nature and causes of such spillovers (especially in the context of a developing country), we try to avoid forming arbitrary algebraic characterizations as much as possible, and abstain from modeling the public sector as an optimizing agent.

Third, one has to note that the adjustment path as characterized by the simulation exercises reflect a smooth *equilibrium* time horizon, in the absence of rigidities and/or structural bottlenecks. Thus, the speed of transitional adjustments in the model economy should not be taken as a measure of the global stability properties of the real economy, but rather as a direct outcome of the laboratory characteristics of a set of macroeconomic simulations. For these reasons, our results should at best be regarded as crude approximations of the long-run equilibrium effects of public debt management and of foreign trade policies on current account, output, capital accumulation and consumer welfare.

The model results reveal that postponement of adjustment to growing public debt and fiscal imbalances is detrimental, in that it merely warrants a deeper and wider use of the relevant tax instruments in due course. The simulation results suggest that with prolonged reliance on the debt instruments, governments may aggravate the fragility of the domestic asset markets, and lead to a distortion of the intertemporal decisions such as consumption/saving and investment. The results indicate substantial losses of potential output, and a significant loss of consumer welfare contrary to expectations of increased efficiency of resource use due to first best economic environment of the trade reform.

In the face of delaying the necessary fiscal reforms, our experiments reveal rapidly expanding ratios of the stock of domestic debt to GDP, and interest costs account for almost a third of the aggregate fiscal revenues under conditions of long-run equilibrium. With relative contraction of the gross domestic product, the burden of the fiscal debt is more severe, and the path of private investment is significantly impeded.

Social welfare gains were computed as changes in the equivalent variations. The first best policy environment, with perfect policy coordination between trade and fiscal reforms, leads to positive gains in this measure. The distortionary environment of delayed/uncoordinated fiscal reforms, however, significantly reduces such potential gains. Our results show that the more delayed the necessary adjustments

towards sustainable fiscal targets, the severer is the gap between the realizations of the gains from liberalization market and the theoretical expectations.

Under the analyzed patterns of fiscal adjustment and tariff liberalization there could likely to be sizable increases in trade deficits of the Turkish economy as, initially, imports grow faster than exports, and investment increases. This would naturally call for the feasibility of access to foreign funds to finance the import-export gap. A key concern here is the fragility of the current external position of Turkey, given the international standards. As shown by the experiments undertaken to capture the conditions of worsening fiscal balances and increased servicing costs of external public debt, the economy would be restricted to a slower growth path, with a significant rise in domestic resource costs to attain equilibrium in the commodity markets and to accommodate the fiscal demands of the state.

Finally, we believe that the modeling approach presented in this study provides a viable example for an integrated treatment of the trade and fiscal reform policies within a multi-sector, multi-factor intertemporal general equilibrium model. It is now a well-recognized feature of modern macroeconomic thought that the analytics of fiscal debt management and trade reform require an intertemporal framework where the full solvency constraints of both the public and the private sectors are taken into account. By way of incorporating explicit intertemporal optimizing behavior on the part of private agents, and an explicit recognition of the intertemporal budget constraint of the government simultaneously within an open economy framework, we were able to address numerically many questions of how the incidences of import tariffication and income taxation affect rates of growth, capital accumulation, and consumer welfare in a manner of theoretical consistency.

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## Appendix I. Equations and Variables of the Intertemporal Model

### A.1. List of equations

#### The time-discrete intertemporal utility

(The elasticity of intertemporal substitution is chosen as one)

$$U_1 = \sum_{t=1}^{\infty} \left( \frac{1}{1+\rho} \right)^t \left[ \sum_i (a_i \ln c_{i,t}) \right]$$

#### Intertemporal Value of Firms

$$V_{i,1} = \sum_{t=1}^{\infty} \frac{1}{\prod_{s=1}^t (1+r_s^D)^t} \left[ PVA_{i,t} (f_i(K_{i,t}, L_{i,t}) - adjcost_{i,t}) - w_t L_t - PI_{i,t} I_{i,t} \right]$$

$$adjcost_j = \phi_j \frac{I_j^2}{K_j}$$

#### Within period equations (time subscript is omitted)

##### A.1.1 Armington Composite Functions

$$PC_i = \frac{1}{\Lambda_i} \left[ \beta_i^{\sigma m_i} (PWM_i(1+tm_i))^{1-\sigma m_i} + (1-\beta_i)^{\sigma m_i} PD_i^{1-\sigma m_i} \right]^{\frac{1}{1-\sigma m_i}}$$

$$\frac{M_i}{C_i} = \Lambda_i^{1+\sigma m_i} \left[ \beta_i \frac{PC_i}{PWM_i(1+tm_i)} \right]^{\sigma m_i}$$

$$\frac{D_i}{C_i} = \Lambda_i^{1+\sigma m_i} \left[ (1-\beta_i) \frac{PC_i}{PD_i} \right]^{\sigma m_i}$$

##### A.1.2 CET Functions

$$PX_i = \frac{1}{\Gamma_i} \left[ \eta_i^{-\sigma_i} (PWE_i)^{1+\sigma_i} + (1-\eta_i)^{-\sigma_i} PD_i^{1+\sigma_i} \right]^{\frac{1}{1+\sigma_i}}$$

$$\frac{E_i}{X_i} = \Gamma_i^{-(1+\sigma_i)} \left[ \eta_i \frac{PX_i}{PWE_i} \right]^{-\sigma_i}$$

$$\frac{D_i}{X_i} = \Gamma_i^{-(1+\sigma_i)} \left[ (1-\eta_i) \frac{PX_i}{PD_i} \right]^{-\sigma_i}$$

#### A.1.3 Value Added and Output Prices

$$PVA_i = \frac{1}{A_i^{\alpha_i} (1-\alpha_i)^{(1-\alpha_i)}} Wk_i^{\alpha_i} Wl^{(1-\alpha_i)}$$

$$PVA_i = (1 - it_i) PX_i - \sum_j PC_j IO_{ij}$$

#### A.1.4 Factor Market Equilibrium

$$\alpha_i PVA_i X_i = Wk_i \cdot K_i$$

$$\sum_i (1 - \alpha_i) PVA_i X_i = Wl \cdot L$$

#### A.1.5 Private Demand System

$$CD_i = \frac{\alpha_i (Y - SAV)}{PC_i}$$

$$INTD_i = \sum_j IO_{ij} X_j$$

$$INV_i = \frac{\theta_{ij} PI_j I_j}{PC_i};$$

#### A.1.6 Household Income

$$Y = (1 - ty) \left[ Wl \cdot L + r^F BF + r^D BPG + TI + \sum_i div_i \right]$$

$$div_i = Wk_i K_i - PVA_i \phi_i \frac{I_i^2}{K_i} - PI_i I_i$$

#### A.1.7 Commodity Market Equilibrium

$$C_i = CD_i + GD_i + \sum_j INV_{ji} + INTD_i$$

#### A.1.8 Government Fiscal Balances

$$GREV = ty \cdot HY + \sum_i tm_i PWM_i M_i + \sum_i it_i PX_i X_i$$

$$GEXP = TI + \sum_i PC_i GD_i + r^D BPG + r^F BFG$$

$$GBOR = GEXP - GREV$$

$$PC_i GD_i = \gamma_i GDP \quad i \neq PSRV \text{ (public services)}$$

$$GD_{PSRV} = Wl \cdot L_{PSRV}$$

#### A.1.9 Domestic Interest Rate

$$\pi = \phi \frac{GBOR}{GDP}$$

$$r^D = (1 + \pi)r^F$$

#### A.1.10 Trade Balance

$$FBAL = \sum_i (PWE_i E_i - PWM_i M_i)$$

$$FBAL = FBOR + GFPAY$$

## Dynamic Difference Equations

### A.1.11 Euler Equation for Consumption

$$\frac{Y_{t+1} - SAV_{t+1}}{Y_t - SAV_t} = \frac{1 + r_{t+1}^D}{1 + \rho}$$

### A.1.12 Non-Arbitrage Condition for Investment

$$q_i = PI_{i,t} + 2 \frac{adjcost_{i,t}}{I_{i,t}}$$

$$(1 + r_t^D)q_{i,t-1} = Wk_{i,t} + adjcost_{i,t} + (1 - \delta_i)q_{i,t}$$

### A.1.13. Sectoral Capital Accumulation

$$K_{i,t+1} = (1 - \delta_i)K_{i,t} + I_{i,t}$$

### A.1.14 Private Foreign Asset Formation (debt if negative)

$$BF_{t+1} = (1 + r_t^F)BF_t + FBOR_t$$

### A.1.15 Government Debt

$$BPG_{t+1} = BPG_t + GBOR_t$$

$$BFG_{t+1} - BFG_t = 0, \quad \text{for all } t.$$

$$GFPAY_t = -R^D_t BFG_{t-1}$$

### A.1.16 Terminal Conditions (Steady State Constraints)

$$\delta_i K_{i,SS} = I_{i,SS}$$

$$V_{i,SS} = \frac{div_{i,SS}}{r_{SS}^D}$$

$$r_{SS}^F BF_{SS} + FBOR_{SS} = 0$$

$$GBOR_{SS} = 0$$

$$r_{SS}^F = r_{SS}^D = \rho$$

#### A.1.17 Welfare Criterion (Equivalent Variation Index)

$$\sum_{t=1}^T \left( \frac{1}{1+\rho} \right)^t \ln \left[ \prod_{i,t} \left( \hat{c}_{i,t}^{a_i} \right) (1+\psi) \right] = \sum_{t=1}^T \left( \frac{1}{1+\rho} \right)^t \ln \left( \prod_{i,t} c_{i,t}^{a_i} \right)$$

where,  $\hat{c}_{i,t}$  is base year consumption for good  $i$ . Thus, A.1.17 states that the welfare gain resulting from the policy shocks is equivalent from the perspective of the representative consumer to increasing the reference consumption profile by  $\psi$  percent.

## A.2. Glossary

### A.2.1 Parameters

$\Lambda_i$	shift parameter in Armington function for good i
$\Gamma_i$	shift parameter in CET function for i
$A_i$	shift parameter in value added function for i
$A_k$	shift parameter in capital good production function
$a_i$	share parameter in private consumption demand function for i
$\alpha_i$	share parameter in value added function for i
$\beta_i$	share parameter in Armington function for own good i
$\eta_i$	share parameter in CET function for own good i
$\theta_{ij}$	share parameter in capital good production function for input-i, sector-j
$\sigma m_i$	elasticity of substitution in Armington function for i
$\sigma e_i$	elasticity of substitution in CET function for i
$IO_{ij}$	input-output coefficient for i used in j
$\rho$	rate of consumer time preference
$\delta_i$	capital depreciation rate
$\phi_i$	capital installation adjustment cost parameter
$\gamma_i$	sectoral government consumption share
$\varphi$	risk function parameter

### A.2.2. Exogenous variables

$L_t$	labor supply
$tm_{it}$	tariff rate for i
$it_{it}$	indirect tax rate for i
$ty_t$	income tax rate
$PWM_{it}$	world import price for good i
$PWE_{it}$	world export price for good i
$r^F_t$	world interest rate

### A.2.3. Endogenous variables

PD<sub>it</sub> own good price for i  
PX<sub>it</sub> producer price for i  
PC<sub>it</sub> composite good price for i  
PVA<sub>it</sub> price of value added for i  
PI<sub>it</sub> unit price of investment quantity in sector i  
q<sub>it</sub> shadow price of capital in sector i  
div<sub>it</sub> dividends of sector i  
Wl<sub>t</sub> wage rate  
Wk<sub>it</sub> marginal product of capital in sector i  
X<sub>it</sub> output of good i  
C<sub>it</sub> total absorption of composite good i  
D<sub>it</sub> own good i  
M<sub>it</sub> import good i  
E<sub>it</sub> export good i  
TC<sub>t</sub> aggregate private consumption  
CD<sub>it</sub> private consumption demand for composite good i  
INVD<sub>ijt</sub> investment demand for composite good i, from sector j  
INTD<sub>it</sub> intermediate demand for composite good i  
Y<sub>t</sub> household income  
SAV<sub>t</sub> household savings  
K<sub>it</sub> capital stock in sector i  
I<sub>it</sub> investment quantity in sector i  
FBOR<sub>t</sub> new purchases of foreign assets held by the private sector  
FBAL<sub>t</sub> trade surplus (deficit if negative)  
BF<sub>t</sub> private foreign assets  
GREV<sub>t</sub> government revenues  
GEXP<sub>t</sub> government expenditures  
GBOR<sub>t</sub> government domestic borrowing  
GFPAY<sub>t</sub> interest payments on external public debt  
BPG<sub>t</sub> government domestic debt  
GD<sub>it</sub> sectoral public consumption  
 $\pi_t$  risk premium

$r^D_t$  domestic interest rate  
 $TI_t$  transfers (set at a given ratio of GREV)  
 $adjcost_{it}$  capital adjustment cost in sector i  
 $V_{it}$  value of the firm.

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