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### Fiscal Debt Management, Accumulation and Transitional Dynamics in a CGE Model for Turkey

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# *Fiscal Debt Management, Accumulation and Transitional Dynamics in a CGE Model for Turkey\**

Xinshen Diao  
Terry L. Roe  
and A. Erinc Yeldan

## ABSTRACT

*We use a dynamic general equilibrium model based on intertemporally optimizing agents to study alternative debt management policies for the Turkish economy. The model is based on the neoclassical growth theory in its adjustment to steady state dynamics, and on Walrasian general equilibrium theory of a small open economy in attaining equilibrium in its commodity and factor markets. Key features of the model are its explicit recognition of the distortionary consequences of excessive borrowing requirements of the public sector through increased domestic interest costs; and endogenous determination of the private work force participation decisions in response to changing tax incidences. The model results suggest that reliance on indirect taxes, as in the current stance of the fiscal authority, has appealing results in terms of attaining fiscal targets, yet it suffers from distortionary consequences and loss of economic welfare.*

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## RÉSUMÉ

*Les auteurs se basent sur le modèle d'équilibre général dynamique de facteurs inter-temporaires d'optimisation pour étudier les politiques alternatives à la gestion des dettes dans l'économie turque. Le modèle est originaire de la théorie néo-classique de croissance dans l'ajustement aux dynamiques étatiques et de la théorie walrasienne du maintien d'équilibre pour les économies de petite taille dans les marchés de commodités. Ce modèle souligne les conséquences perverses des règlements d'emprunt excessifs que le secteur publique impose, par le biais des augmentations d'intérêts, et de la détermination du secteur ouvrier privé faisant face aux fluctuations d'impôts. Les résultats indiquent que lorsque le gouvernement s'appuie sur les impôts indirects, il amène, malgré les résultats impressionnants, des conséquences qui peuvent être désastreuses au bien-être de son économie.*

## INTRODUCTION

For many developing economies, the 1990s have brought external shocks with faltering export demand, high and volatile real interest rates and reduced funds for external finance. By 1990, many governments in developing countries were used to relying on external sources to finance their fiscal operations. Under such conditions, constraints to growth were thought to originate from two gaps: savings-investment and foreign exchange. With the darkening external environment, however, the countries found themselves having to extract resources from the internal markets to sustain their fiscal targets. That in turn meant that domestic debt accumulation and the emergence of the so-called "fiscal constraint" as the third gap limiting the growth prospects (Bacha, 1990; Taylor, 1996).

Aware of the inflationary consequences of monetization, many governments resorted to administered bond financing at controlled rates of return, and/or levying high taxes on financial transactions. Such attempts to reduce the fiscal gap by using forced sales of low-yield public securities, however, crowded out the private sector from the financial markets and discouraged financial intermediation (Blejer and Cheasty, 1989). In the face of ad hoc and often contradictory modes of fiscal finance, these elements led to sporadic financial crises and carried with them an enormous potential for arbitrary wealth redistribution (Diaz-Alejandro, 1985).

Compared with many developing countries, Turkey had experienced relatively modest sizes of accumulated fiscal debt by 1996. However, two factors increased the gravity of the problem. One factor was the fiscal authorities' realization 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, the deficit had to be increasingly financed

by domestic sources through bond issues at very high real interest rates to cover the risk premiums. The second factor was the very short maturity of the domestic debt, which gave way to an intensive Ponzi financing mode of debt management. Together, these factors led to excessively high interest rates, crowded out private investors and caused significant strain on domestic markets.

In this paper, we develop a dynamic computable general equilibrium (CGE) model to analyze issues of fiscal debt management, foreign trade, accumulation and transitional growth dynamics for Turkey. The model is designed to capture a detailed treatment of intersectoral effects along with an intertemporally consistent treatment of short- and long-run adjustments to policy shocks. 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 premiums apparent in the data. We use the model to simulate both the short-run (upon impact) and long-run (transitional) dynamic effects of alternative taxation regimes and foreign exchange constraints on Turkish economy.

The integrated treatment of intertemporally dynamic adjustments within a multi-sector, multi-factor model offers several attractions for fiscal policy analysis. Traditional CGE analyses of taxation and trade liberalization could only account for the static, once-and-for-all effects, and could not capture the long-run dynamic effects that involve intertemporal behaviour such as saving and investment decisions. The incorporation of saving and investment decisions in the CGE models of the static-genre depends on the parametrization of fixed savings rates out of disposable income and on ad hoc macro closures. These approaches often led to weak policy results, with arbitrary dependence on modeling specifications (Devarajan and Go, 1995; Srinivasan, 1982). By incorporating explicit intertemporal optimizing behaviour on the part of rational agents, we address many questions about the long-run effects of tax incidence, fiscal debt, foreign exchange constraints on growth, accumulation and consumer welfare.

In section I, we provide an overview of the recent developments in the Turkish economy, with special emphasis on fiscal policy issues. We introduce the characteristics of the model in section II and implement our policy simulations in section III and summarize our comments in the conclusion.

## I. AN OVERVIEW OF THE TURKISH ECONOMY IN THE 1990S

The growth performance of the post-1990 Turkish economy was one of miniature boom-and-bust cycles. Gross domestic product (GDP) fluctuated greatly, with growth rates of growth recording sharp peaks (9.3% in 1990, 8.0% in 1993, and 7.2% in 1995 and 1996) being immediately followed by

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severe contractions (0.9% in 1991 and 5.5% in 1994). The cyclical pattern is observed to be closely related to the foreign exchange gap. In general, years of high growth were associated with the availability of external finance to cover the current account deficits and with the expansion of imports. The impact of the ongoing import liberalization was more effective than the export drive, which, by 1990, had lost its thrust of the 1980s (Boratav, Türel and Yeldan, 1996b).

The 1990s has also been characterized by a rapid deterioration of the state's fiscal position (Sak, Özatay, and Öztürk, 1996; Atiyas, 1995; Boratav, Türel and Yeldan, 1996a; Önder et.al., 1993). The major breakdown has occurred in the flow of factor revenues generated by the state's economic enterprise system, and in the rapid rise of transfer expenditures (table 1). This phenomenon resulted mainly from the sudden increase in real wage costs, fueled by political-economy pressures of the civilian elections of 1989 and 1990. Real wages rose by 65.1% from 1989 to 1991. Factor revenues declined by TL 4.6 trillion in 1987 values from 1988 to 1992. Although tax revenues modestly improved, the surge in transfer expenditures outweighed the gains. As a ratio of gross national product (GNP), current transfers rose from 6.1% in 1991 to 13.4% in 1996. The savings-generation capacity of the public sector also eroded severely and turned negative after 1992. The aggregate disposable income of the public sector fell by 30% in real terms between 1988 and 1995, and the public savings-investment gap nearly quadrupled.

Because income tax reform is politically unfeasible, successive governments have to rely on indirect taxation. Revenues from indirect taxes exceeded those of the direct taxes by an average of 50% during the 1990s. With the recent move toward a customs union with the European Union (EU) in 1995, however, Turkey agreed to harmonize its tariff system with that of the EU. The resulting revenue losses in trade taxes for the Turkish treasury placed additional strain on the fiscal balances. Harrison, Rutherford and Tarr (1996) estimate that value-added taxes must be increased by 16.2% to compensate for this loss of revenue. Köse and Yeldan (1995) incorporated oligopolistic mark-up pricing to a similar static CGE of 26 sectors and found the necessary indirect tax adjustment to reach 36%.<sup>1</sup>

These developments led to a sharp increase in the public sector borrowing requirement (PSBR), which increased to as much as 11.7% of the GNP in 1993, just before the outbreak of the 1994 economic crisis. Since external

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1. See Mercenier and Yeldan (1997) for an intertemporal general equilibrium analysis of Turkey's recent move to integrate trade 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 1990s.

Table 1. Main economic indicators and fiscal balances of Turkey

Annual change (%)	1985	1990	1991	1992	1993	1994	1995	1996
GDP	4.2	7.9	1.1	5.9	8.0	-5.5	7.2	7.2
Consumption								
Private	4.4	13.1	1.9	3.3	8.4	-5.3	5.6	8.6*
Public	1.7	7.9	4.5	3.8	2.3	-3.5	6.7	7.7*
Fixed capital formation								
Private	7.6	19.4	0.9	4.3	34.6	-9.1	17.9	13.7*
Public	5.7	8.9	1.8	4.3	3.4	-34.8	-12.4	30.5*
Exports	7.3	10.6	4.9	9.0	4.8	17.8	19.5	6.8
Imports	5.5	41.2	-5.6	8.7	28.7	-20.9	53.5	18.9
Inflation rate (CPI, %)	44.9	60.4	71.1	66.0	71.1	106.3	88.0	84.9
Index of real wages in manufacturing industries**	100.0	139.9	168.2	159.0	158.8	111.2	116.5	128.0
Real exchange rate***	100.0	89.0	90.5	94.2	95.2	117.4	102.2	102.6
Real interest rate on GDIs (%)§	-	-4.0	5.3	13.9	9.9	29.3	18.1	29.0
Ratios to GNP %								
Tax revenues								
Direct	4.7	6.5	7.0	7.3	7.1	8.0	6.6	6.6
Indirect	7.2	8.9	9.3	10.0	10.5	10.4	10.8	11.2
Public sector factor income	5.2	3.1	0.6	-0.1	0.6	1.9	2.2	3.8
Public sector current transfers	-4.9	-6.5	-6.1	-6.7	-9.2	-12.0	-11.4	-13.4
Public disposable income	14.4	13.4	11.8	11.4	9.6	8.9	8.2	6.8
Budget deficit	-2.2	-3.1	-5.3	-4.3	-6.8	-3.7	-4.0	-8.8
PSBR	3.6	7.4	10.3	10.6	11.7	8.2	6.6	9.6
Govt. net foreign borrowing	-0.6	0.9	0.4	1.6	1.4	-1.8	-0.9	-1.4
Interest payment on:								
domestic debt	0.7	2.4	2.7	2.8	4.6	6.1	6.2	9.0
foreign debt	1.2	1.1	1.1	0.9	1.2	1.6	1.3	1.2
Stock of GDIs***	4.5	7.0	8.1	11.7	12.8	14.0	14.6	18.8
Current account balance	-1.5	-1.7	0.2	-0.6	-3.5	2.0	-1.4	-2.4
New govt. borrowing/domestic								
Debt stock (%)	52.0	52.3	67.0	94.4	105.3	128.9	129.4	163.5

Sources: SIS Annual Statistics, Undersecretariat of Treasury and Foreign Trade, Main Economic Indicators

Notes:

\*. January-March

\*\*. Index (1985 = 100) of annual real wages in private manufacturing industry employing 10 or more workers, deflated by the CPI

\*\*\* Index (1985 = 100). An increase indicates *depreciation* of the TL.

§ Annual average of compound interest rate on government debt instruments (GDI), deflated by the CPI

§§. GDI not including central bank advances and consolidated debts

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sources of public sector financing were extremely limited,<sup>2</sup> the state was forced to resort to a massive operation of domestic debt financing by issuing new debt instruments and implementing both market and administrative (non-market)

2. Net foreign borrowing of the government from 1989 to 1997 was almost negative, and in those years when the public sector experienced *net inflows*, it barely reached 1% of GNP (Yeldan, 1997b).

mechanisms to transfer resources from the private sector. With the introduction of an auction market for public sector debt instruments in 1986, a complex system of incentives was enacted. The incentives involved tax exemptions on government securities and risk-free net yields exceeding the returns offered by many alternative assets. The real interest rate offered on government bonds increased to as high as 29% in 1994 and 1996, far exceeding the real return on one-year term deposits (table 1). The government's debt instruments dominated the financial markets almost exclusively. In 1996, the new issues of public securities accounted for 90% of all securities and the share of public assets in the secondary market reached 95% (Balkan and Yeldan, 1998).

Under these conditions, the stock of domestic debt grew rapidly and reached 20% of the GNP by the end of 1996. Interest payments on domestic debt increased from 2.4% in 1990 and to 9.0% of the GNP in 1996. A critical feature of debt accumulation was its extremely short-term maturity. By 1992, the state was already trapped in a Ponzi-style financing of its debt, with net new government borrowings reaching 94.4% of the domestic debt. By 1996, this ratio accelerated to 163.5%. Thus, management of the domestic debt and the release of the fiscal gap emerged as a major concern for the Turkish policy makers in the second half of the 1990s. We will attempt to address these issues in the following sections of the paper.

## II. THE MODEL

With some modification, the model used 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 on the recent contributions on intertemporal GE modeling by Wilcoxon (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), Turkey's recent input-output table of (SIS, 1994), and other sources to represent the macroequilibrium of the Turkish economy in 1990. We aggregate production activities into six sectors (agriculture, consumer manufacturing, producer manufacturing, intermediates, private services, and public services), using labour and capital to produce the respective single outputs. With fixed endowment<sup>3</sup>, labour is mobile across sectors but is not mobile internationally. The private household chooses its allocation of labour supply to work or to leisure based on optimization, given

3. This specification has no real effect on the model because we could normalize all variables in *per capita* terms.



market prices and wage remunerations. 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 is ignored.

#### A. HOUSEHOLD AND CONSUMPTION SAVINGS

The representative household owns labour and all private financial wealth, and allocates income to consumption and savings to maximize an intertemporal utility function over an infinite horizon:

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$$\text{Max } U_1 = \sum_{t=1}^{\infty} \left( \frac{1}{1+\rho} \right)^t \frac{FC_t^{1-\theta} - 1}{1-\theta} \quad (1)$$

subject to the intertemporal wealth constraint:

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

where  $\rho$  is the positive rate of time preference;  $\rho$  is inverse of the intertemporal elasticity of substitution; and  $FC_t$  is full consumption at time  $t$ . Full consumption, in turn, is allocated into leisure,  $LEIS_t$ , and commodity consumption. The opportunity cost of leisure is given by the market wage rate,  $w_t$ ; and total commodity consumption is composed of sectoral consumption demand,  $c_{it}$ ; via  $TC = \prod c_{it}^{a_i}$  and with the consumption shares satisfying  $0 < a_i < 1$ , and  $\sum a_i = 1$ . Finally,  $p_{i,t}$  is the price for good  $i$ ;  $TW_1$  is the initial private wealth; and  $R_t$  is a discount factor defined as:

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

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

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

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

### C. FIRMS AND INVESTMENT

The representative firm in each sector carries both production and investment decisions to maximize the value of the firm. The firm's intertemporal decision problem can be stated as follows: in each sector- $i$ , the firm chooses the levels of investment,  $I_{i,t}$ , and labour employment to maximize the present value of all future profits while taking into account the expected future prices for sectoral outputs, the wage rate, the capital accumulation constraint and the capital adjustment cost function,  $a_{i,t} = \phi \frac{P_{i,t}}{K_{i,t}}$ . Specifically, the firm chooses the following sequences  $\{I_{i,t}, L_{i,t}\}$ , subject to the capital accumulation constraint:

$$\begin{aligned} \text{Max } V_i = & \\ \sum_{t=1}^{\infty} R_t \text{div}_{i,t} \equiv & \sum_{t=1}^{\infty} R_t \left[ PV A_{i,t} (f_i(K_{i,t}, L_{i,t}) - a_{i,t}) - w_t L_{i,t} - I_{i,t} \right] \quad (5) \end{aligned}$$

where  $V_i$  denotes the current market value of the firm. Because of the recognition of adjustment costs on capital, marginal products of capital differ across sectors, resulting in unequal, but optimal investment rates. The new capital equipment,  $I_i$ , is produced by forgone outputs of the six sectors with a Cobb-Douglas function; therefore,  $PI_i$ , can be written as a function of the final good prices. However,  $PI_i$  only represents the unit cost of the foregone 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 as follows:

$$q_i = PI_i + PV A_i \frac{\partial a_i}{\partial I_i} \quad (6)$$

### D. GOVERNMENT AS THE FISCAL AUTHORITY

The government has four interrelated functions in the model: to collect taxes, to distribute transfer payments, to purchase goods and services, and to administer domestic public debt.

The model distinguishes three types of taxes. 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.

The government's basic spending includes the transfer payments to households, public consumption expenditures (including public service wages costs) and interest costs on public debt. A government budget deficit may arise from the excess of aggregate expenditures over the tax income.<sup>4</sup> The fiscal deficit is financed exclusively through new issues of government bonds. Thus, government bonds issued at time  $t$  are defined as

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

and

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

where  $GDEF_t$  is the government's budget deficit at time  $t$ ;  $BFG_t$  is the public sector stock of foreign debt;  $HY_t$  is household gross income;  $tx_{it}$  is the indirect tax rate for sector  $i$ ;  $PX_{it}$  is the output price of good  $i$ ,  $X_{it}$  is the output of good  $i$ ;  $tm_{it}$  is the tariff rate;  $PWM_{it}$  is the world price for imported good  $i$ ; and  $M_{it}$  is 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 is financed exclusively by new issues of public debt instruments, which are purchased by 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 that transfer payments are proportional to aggregate government revenues, while the total public consumption of goods (excluding public services) is set as a constant share of the  $GDP$ . Similarly, sectoral purchases are distributed given fixed expenditure shares.

4. Although this formulation of the government's fiscal position is fairly general, opinions differ on the precise calculation of the public sector's budget constraint. In their extensive survey on the measurement of fiscal deficits in various countries, Blejer and Cheasty (1992) 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, p. 56) assessment of the deficit-generating components, where "expenditure includes wages of public employees, spending on goods and fixed capital formulation, 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."

## D. 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 produced goods are regarded as imperfect substitutes in aggregate demand, given an elasticity of substitution/transformation. The economy is small, hence, world prices are regarded as 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 public service wages, and is therefore regarded as a home (non-traded) good with the government being its sole buyer.

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

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

## C. 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) producers' demand for labour plus households' leisure demand equal total labour supply; and (iii) government spending equal government revenues plus new issues of public debt instruments. The inter-temporal equilibria are further constrained by the following steady state conditions:

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

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

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

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

Equation 10 implies that at the steady state, the value of the firm,  $V_{ss}$ , becomes constant, the profits,  $div_{i,ss}$ , are therefore 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; the stock of capital therefore remains constant. Equation 12 states that foreign

asset holdings are constant. Equation 13 is the solvency (transversality) condition on government debt,<sup>5</sup> which requires that government debt be constant at the steady state. This implies that the government must have a surplus on its primary budget that equals its interest payments on its domestic and foreign debt.

#### IV. ANALYSIS OF ALTERNATIVE POLICY REGIMES

##### A THE EXPERIMENTS AND THEIR MOTIVATIONS

As described in section II, the fiscal balances of the Turkish state eroded severely during the 1990s. Successive governments faced an increased need to find domestic sources for financing their borrowing requirements, because the foreign sources of debt finance were limited. Consequently, the size of the domestic debt rose rapidly to reach 18.8% of GNP in 1996 from a mere 6.3% in 1989.

In this section, we analyze the domestic debt management options of the fiscal authority from the point of view of consumer welfare and the resource allocation process. To do this, we first perturb the base-run steady state by a parametric erosion of fiscal balances. We try to capture the major shifts of this period by a permanent rise of transfer expenditures and by the loss of trade tax revenues. The first shock is designed to capture the increased domestic pressures on the fiscal authority; the second attempts to accommodate the post-1995 customs union environment in foreign trade policy.

More formally, we first increase the government's transfer payments by 100% in real terms; second, we eliminate all tariffs on imports. On the one hand, the rise in the fiscal deficit is met entirely by issuing domestic debt instruments, which are held exclusively by the domestic private sector. Persistent fiscal deficits require the extraction of funds from the capital markets which could otherwise be used in new capital formation. On the other hand, the ongoing increase in the public sector's borrowing requirement 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 domestic financial markets, transactors often face higher interest costs than those that prevail in the international markets. A risk premium therefore emerges between the domestic and the international interest rates, leading to the distortion of the savings and investment decisions of residents.

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<sup>5</sup> Since the interest payments are recorded for the current period public expenditures, this steady state does not result in interest costs.

Given this background, we consider the following three alternative debt management policy scenarios and environments for adjustment: in the first experiment (EXP-1), we envisage an environment in which trade and fiscal policies are perfectly coordinated, and, to compensate for the losses of fiscal revenues, we endogenously adjust the income tax rate. Thus, the government's fiscal budget balance is maintained continuously for all time periods. In the second experiment (EXP-2), we switch to a mode of indirect (producer) taxation. We adjust indirect taxes by 100% to ease the fiscal constraints on the government's budget. For the imposition of the transversality condition of the government, we again rely on the endogenous income tax rate, this time starting after period 20.<sup>6</sup> In the third and final experiment (EXP-3), we use income taxation as the main source of fiscal revenue. Here, we increase the income tax rate by 100% in period 1. As in EXP-2, we implement the transversality condition of the government starting in period 20, by endogenizing the income tax rate thereafter. We allow the domestic rate of interest to bring forth the necessary adjustment. Table 2 summarizes the highlights of each experiment.

We will use the path EXP-1 as our benchmark against which the distortionary policy environments of the latter experiments will be contrasted. The intertemporal fiscal constraint can also be used as a benchmark for evaluating current (ex-ante) debt policies of the fiscal authority for a normative evaluation (Velthoven, Verbon and Van Winden, 1993). For instance, if the existing public debt equals the present discounted value of future primary (non-interest) surpluses, then the government is said to satisfy its intertemporal constraint and is therefore said to be solvent. Buiter (1989) adopts this approach to compare whether, in selected industrial countries, the current debt ratios are sustainable with permanent primary surpluses.

In the context of Turkey, based on a similar analysis, Özatay (1996) recently tested whether the present value borrowing constraint is satisfied for the Turkish economy. Using monthly data from 1985 to 1993, Özatay found evidence that the domestic debt strategy was not sustainable in the long run

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6. Our focus is on the evolution of the transition path, rather than on the time period when the economy has approached the fully intertemporal equilibrium – the steady state. The eventual balancing of the government's budget is part of the technical constraints of intertemporal equilibrium. This implies that, from a technical point of view, the government eventually has to raise taxes and/or adjust expenditures to meet the steady state equilibrium constraint on fiscal balances. The model on its own cannot tell us when this endogenous adjustment should be imposed; one has to impose this constraint at an arbitrary point. We therefore 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 only 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.

Table 2. Summary of simulation experiments

Experiment 1	Experiment 2	Experiment 3
Simultaneously adjust the income tax rates such that the government current budget holds for all time periods.	1. Rely on indirect taxation to raise government revenues. This scenario highlights much of the macroeconomic characteristics of the post-1990 Turkey.	1. Rely on direct income tax by way of an income tax reform, starting at period 1.
	2. After period 20, adjust income tax rate endogenously to impose the government's solvency constraint on its debt.	2. After period 20, adjust income tax rate endogenously to impose the government's solvency constraint on its debt.

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and was the major reason for the confidence crisis, that culminated in the full-fledged financial breakdown of 1994.

EXP-2 distorts the best growth path and, in comparison to EXP-1, should lead to real contraction, and to decrease in consumer welfare. This decrease originates from the distortionary effects of the indirect taxes by opening a wedge between producer and consumer prices. As documented in table 1, Turkish authorities rely exclusively on indirect taxation for public income. Share of indirect taxes reach 65% of aggregate tax revenues in 1996; and the indirect tax rates differ widely across sectors, ranging from -0.7% in agriculture to 27% in petroleum products (SIS, 1994). Thus, in EXP-2, we highlight many of the basic attributes of the Turkish reality of the 1990s by deferring of the necessary adjustments through income tax reform, using instead the proceeds of indirect tax to generate fiscal revenues, relying heavily on the domestic asset markets for financing the fiscal constraint; intensifying the use of the politically motivated high income transfers initiated to the private sector; and diversifying the domestic rate of interest away from the return on international assets.

## B. POLICY ANALYSIS

Our simulation results are shown in table 3, and the adjustment paths of selected variables appear in figures 1-6. All solution results are reported as ratios to the base-run steady state.

Under EXP-1, the government simultaneously adjusts the income tax rate so that its budget balance is continuously maintained. In this policy environment, the intertemporal nature of our model allows us to capture both the static gains from resource reallocation and dynamic gains from increases in

capital investment. Real GDP increases by 1.25% on impact (period 1) and by 8.5% over period 30 (see figure 1, and table 3). Investment demand is stimulated and capital is accumulated along the transitional path (see figure 2 and table 3), allowing consumers to enjoy gains from liberalization by raising their commodity consumption along the whole transitional path. Households reduce their leisure demand, and labour participation rate is increased by 1% in period 1, and by 3.1% in period 19. Yet, the increases in commodity consumption and investment result in an expanding trade deficit and thereby stimulate foreign capital inflows. As the economy specializes in producing goods in which it has a comparative advantage, its exports start to grow faster than its imports after the period 18, and the trade deficit starts to fall thereafter. For example, the manufacturing and the service sectors are the major net export sectors in Turkey. Thus, under EXP-1, liberalization of trade leads to increased investments toward these two sectors, in comparison with those that were under higher tariff protection initially. Thus, outputs and 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 raises production and exports of the sectors in which the economy has a comparative advantage.

We calculate the social welfare gains by constructing an equivalent variation index, which is a function of the current and future aggregate full 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 0.60% during the first 10 periods, and 1.82% by the end of period 30. Together with increased participation in the work force and expansion of the GDP, these gains are mainly the result of tariff liberalization under conditions of perfect policy coordination, with reliance on direct income taxes as first best policy instruments.

Clearly, achieving a balance in the fiscal budget by a simultaneous tax adjustment may not be technically feasible, given the country's tax administration capacity.<sup>7</sup> We therefore invoke the need for an additional tax regime, and, given the current stance of the fiscal authority, we investigate the dynamic consequences of imposing an increase in the average level of the indirect tax rates under EXP-2. With this alternative mode of adjustment,

7. Initial SAM data indicate an effective tax rate of 7% on private incomes. The model results suggest a parametric increase of this rate to 19.9% to impose the intertemporal solvency constraint on fiscal balances.



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 19	Period 1	Period 10	Period 19	Period 1	Period 10	Period 19
Aggregate investment	1.094	1.132	1.155	0.935	0.931	0.944	1.082	1.115	1.148
Aggregate capital stock	1.006*	1.056	1.099	0.995*	0.967	0.951	1.006*	1.049	1.088
Aggregate commodity consumption	1.012	1.025	1.031	0.971	0.983	1.000	1.002	1.019	1.035
Aggregate leisure consumption	0.977	0.963	0.952	0.975	0.987	1.001	0.970	0.963	0.958
Labour participation rate	1.010	1.016	1.021	1.011	1.006	1.000	1.013	1.016	1.018
Government revenues	1.311	1.329	1.345	0.998	0.938	0.915	1.132	1.149	1.171
Government expenditures	1.311	1.329	1.345	1.117	1.158	1.272	1.234	1.307	1.411
Government domestic borrowing	-	-	-	7.204	13.277	21.558	6.193	9.566	14.507
Ratio of government domestic debt to GDP	-	-	-	0.002*	0.282	0.764	0.017*	0.192	0.475
Ratio of interest payments on domestic debt to government revenues	-	-	-	0.005*	0.073	0.208	0.004*	0.046	0.114
Trade deficit	1.642	1.294	0.966	0.060	0.704	1.355	1.359	1.183	1.142
Private foreign borrowing	1.492	1.225	0.974	0.280	0.783	1.288	1.275	1.146	1.118
Domestic interest rate	1.000*	1.000	1.000	1.025*	1.042	1.069	1.018	1.027	1.040
Wage rate	0.977	0.990	1.002	0.881	0.871	0.872	0.968	0.984	1.001
Sectoral outputs									
Agriculture	0.980	0.987	0.997	1.011	1.021	1.026	0.981	0.985	0.993
Consumer manufacturing	0.991	1.033	1.075	1.019	1.043	1.050	0.997	1.032	1.063
Producer manufacturing	0.956	0.914	0.903	0.819	0.555	0.430	0.960	0.910	0.892
Intermediates	0.973	0.960	0.965	0.982	0.880	0.813	0.977	0.957	0.955
Commercial services	1.029	1.093	1.133	1.021	1.026	1.026	1.030	1.087	1.125

\* Period 2

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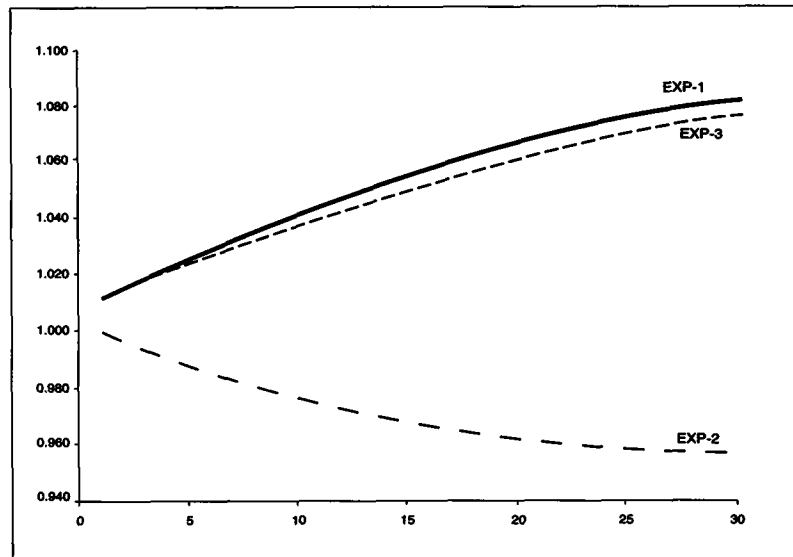


Figure 1. Real gross domestic product (ratios to the base-run steady state)

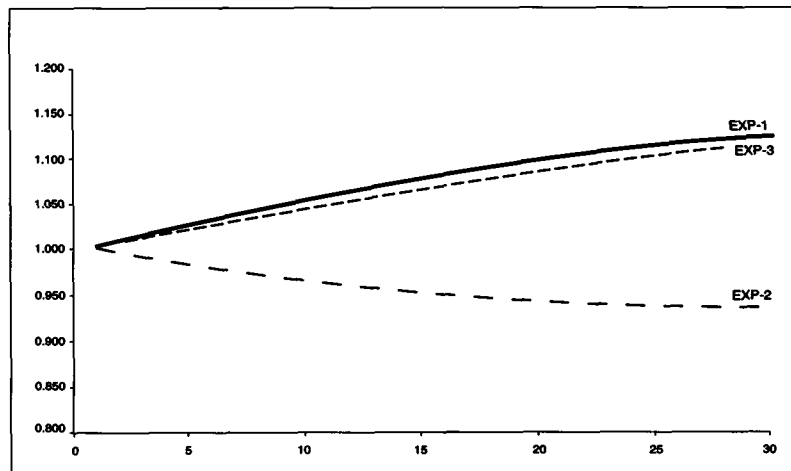
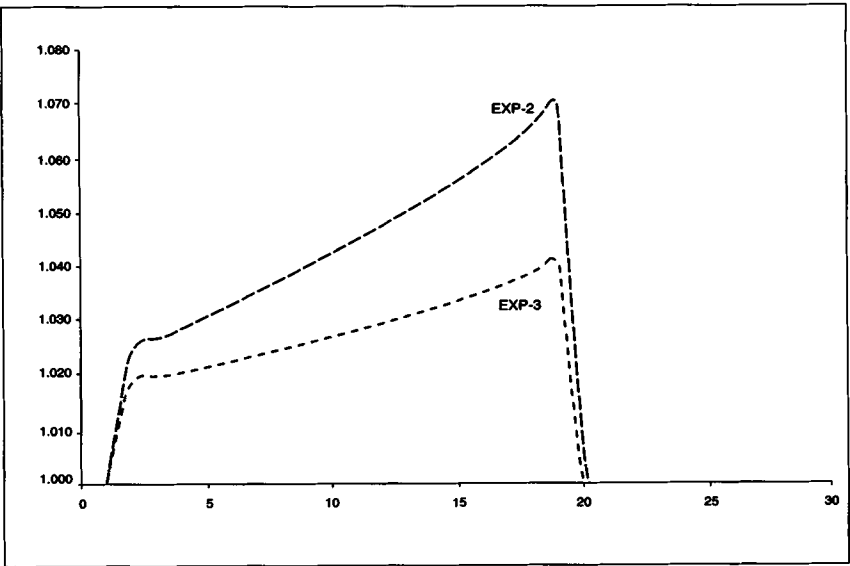


Figure 2. Aggregate capital stock (ratios to the base-run steady state)



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Figure 3. Ratio of the domestic interest rate to the foreign interest rate

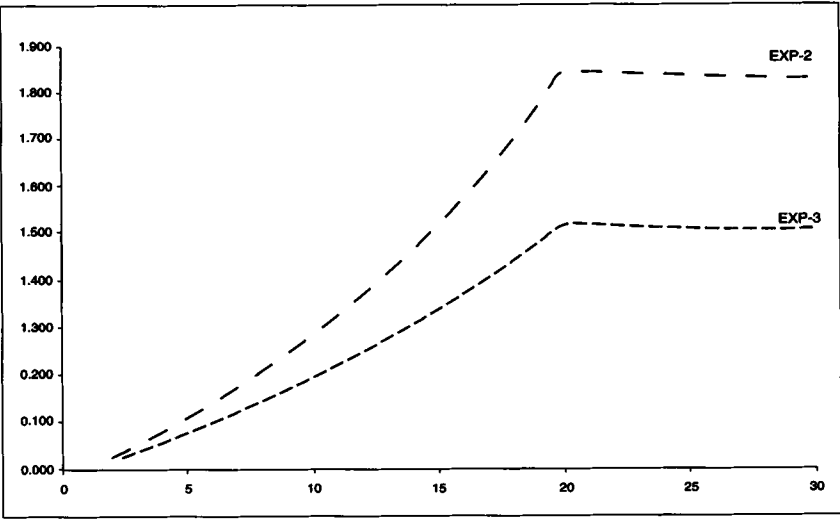


Figure 4. Ratio of government debt stock to GDP

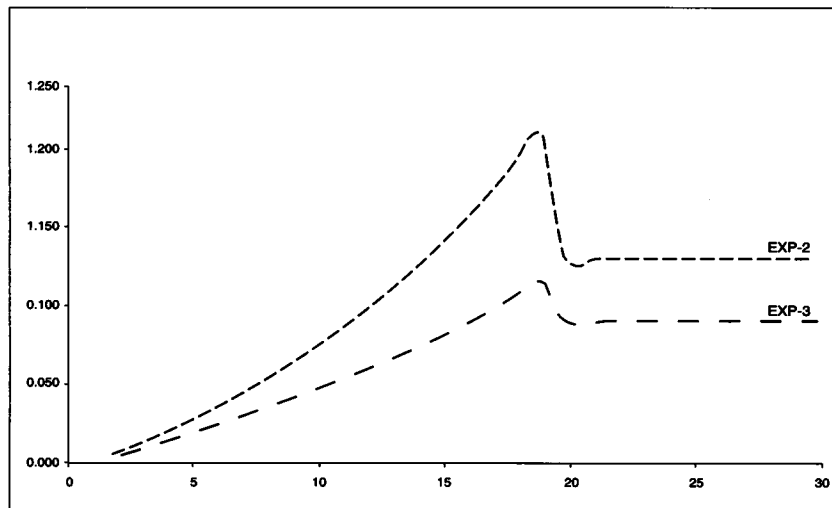


Figure 5. Ratio of interest costs on public debt to aggregate government revenues

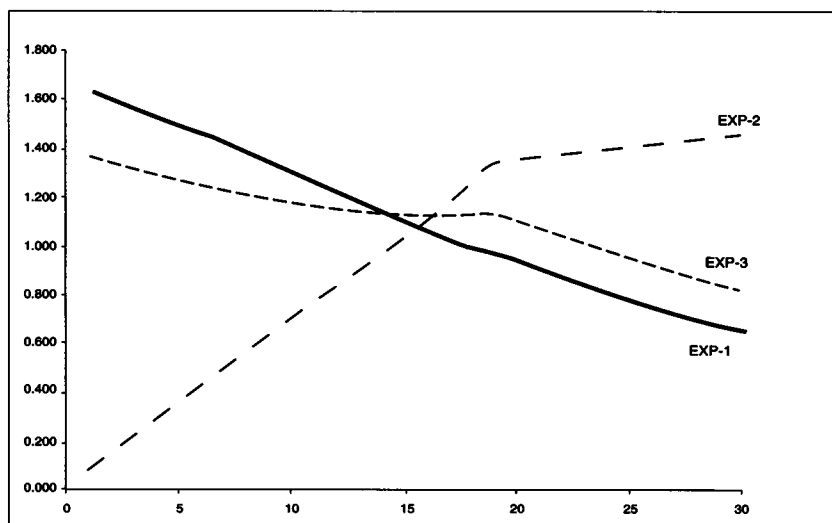


Figure 6. Trade deficit (as a ratio to the base-run steady state)

Table 4. Dynamic effects of alternative policy regimes on consumer welfare (% deviations from the base-run)

	Experiment 1	Experiment 2	Experiment 3
Real gross domestic product			
Period 1	1.252	-0.097	1.307
Period 10	4.342	-2.344	3.906
Period 19	6.651	-3.610	6.000
Period 30	8.578	-4.123	8.075
Changes in consumer welfare index*			
First 10 periods	0.659	-0.843	-0.011
First 19 periods	1.314	-1.018	0.272
First 30 periods	1.817	-1.010	1.571

\* Percentage change in equivalent variation index

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fiscal revenues are generated from the proceeds of indirect taxes; however, these revenues are realized at the cost of distortionary effects of the taxation regime. GDP declines at a significant rate and remains below the base-run steady state path throughout the whole adjustment horizon. Similarly, aggregate consumption and investment are reduced in comparison to EXP-1. Consequently, much of the welfare gains from trade liberalization are offset, and the consumer welfare index falls by 1.0% from its EXP-1 level. Thus, EXP-2 clearly underscores the tensions between the reliance on indirect taxes as fiscal revenue sources and the efficiency losses caused by distortions created in the relative price signals.

EXP-3 resorts to a discretionary income tax adjustment. Here, rather than manipulating the income tax rates continually under perfect policy coordination, we envisage a single parametric adjustment of the effective income tax. EXP-3 clearly outperforms EXP-2 in almost all of the macroaggregates concerned (see table 3). Changes in real GDP become positive (figure 1), and the accumulation of the nationwide capital stock exceeds that of the EXP-2 level by 1.14 by period 19, just before the implementation of the government's fiscal constraint (figure 2).

In both the EXP-2 and EXP-3 environments, in the absence of simultaneous compensating schemes for generating revenue sources, a fiscal gap emerges. The government then resorts to domestic borrowing and issues debt instruments to finance its deficits. However, this added reliance on domestic funds increases uncertainty and the fragility of the asset markets. This makes domestic and foreign investors more likely to discriminate between investing in government debt instruments and other instruments offered on the domestic and international markets at the prevailing interest rate. Our depiction of this phenomenon is based on a simple function that maps the

ratio of the fiscal deficit to GDP onto a risk premium. More formally,  $\pi_t$  denotes the risk premium over the international lending or borrowing rate: where  $\varphi$  is a shift parameter. Thus, the domestic interest rate,  $r_t^D$ , diverges from its foreign counterpart by  $\pi_t$ , i.e.,  $r_t^D = (1 + \pi_t)r_t^F$ .

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

Under these conditions, with the rise of the risk premium, the domestic asset market is more fragile, and the domestic interest rate increases by 2.5 to 6.9% under EXP-2, and by 1.8 to 4.0% under EXP-3 (figure 3).

Under EXP-2, the ratio of fiscal debt to GDP accumulates rapidly as the borrowing conditions from the domestic market become increasingly expensive. To cover the high interest costs, the government must increase its borrowing ever more. Thus, the fiscal debt accumulates more quickly and, for example, by period 10 its ratio to GDP reaches to 28% (figure 4). Interest payments emerge as a major expenditure item. Under EXP-2, interest costs are observed to claim 20% of the aggregate public revenues by period 10, requiring the government to switch to a short-termist strategy of Ponzi style financing based on rolling of debt over time (i.e. the government must issue new bonds to pay the interest on the outstanding debt, which clearly would be sustainable neither politically nor economically (see figure 5). The increase in the domestic interest rate increases costs and reduces expected returns on investment. Hence, aggregate investment falls in comparison with the EXP-1 scenario. Consequently, the aggregate capital remains below its initial steady state level (figure 2).

Deceleration of investment demand and the hesitant accumulation of the physical capital stocks, together with the reluctant participation in the work force result in a stagnant environment in EXP-2. Combined, these factors lead to a fall in the welfare index from its pre-liberalization level, inhibiting some of the potential welfare gains of trade liberalization (table 4). The adjustment path under EXP-3, however, reverses much of this negative trend and portrays a more balanced environment where the fiscal borrowing requirements of the public sector remain modest (see figures 4 and 5, and table 3).

Although the initial design of the model is not suitable for forecasting analysis, one can draw striking parallels between the Turkish economy's actual development path and the results of our simulation experiments under EXP-2 in many macroaggregates concerned, especially in the fiscal indicators. As noted above in section 2-2, the current ratio of the Turkish government's fiscal

debt to GNP stands at about 20%, and the interest costs already account for about 40% of the total budgetary revenues. In contrast, the ratio of fiscal debt to GNP was only 2% as recently as 1990. Thus, the fiscal indicators of the EXP-2 simulation are in stark contrast to Turkey's post-1990 historical realities. As documented in many recent analyses of the Turkish economy (see for example Yeldan, 1997b; Boratav, Türel and Yeldan, 1996a; Özatay, 1996; Sak, Özatay and Öztürk, 1996; Atiyas, 1995), the rapid deterioration of the fiscal balances clearly signals an unsustainable pattern, with annual net new public sector borrowings exceeding the public sector's existing stock of domestic debt. The short term effect of the nature of maturities of the public sector assets on the continued confidence crisis and on the increased fragility (riskiness) of the domestic financial system gives significant cause for concern. These elements, no doubt, lie at the heart of the reason for the presence of significantly high real interest rates in the Turkish domestic asset markets and are directly responsible for the invigoration of a series of adjustments that, 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 at trade reform in an environment characterized by management failures and unsustainable fiscal targets are clearly futile, with realized outcomes falling short of expectations of a more efficient resources allocation and of a rise in social welfare. Our results further underscore that the more delayed the necessary adjustments toward a sound fiscal reform, the wider the gap between such expectations and their realization.

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## CONCLUSION

Before we summarize our main findings, we must outline some of the limitations of the study. First, with this type of a methodology, no distinctive conclusions can be inferred about the characterization of the future path of the economy based on calendar dates. The policy experiments performed are comparative and are meaningful only in relation to each other. They do not reveal forecasts for the future.

Second, both the private and the public sectors are modeled in aggregate terms. The idea of a representative national consumer, though a common device in modern macroeconomic thinking, precludes any analysis of income distribution and may seem implausible. This specification reflects, however, that our main motivation centres on the dynamics of adjustment of the macroaggregates along a transition path in response to broad policy shifts, and on the processes of resource allocation that reflect changes in consumer welfare. Thus, many of our insights derived from the simulation exercises do

not depend on detailed considerations of heterogeneity of the private sector.<sup>8</sup> In a similar vein, the government's savings and investment behaviour are not addressed; 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 avoid forming arbitrary algebraic characterizations as much as possible and abstain from modeling the public sector as an optimizing agent.

Third, the adjustment path as characterized by the simulation exercises reflect equilibrium relationships on a smooth time horizon, mainly in the absence of rigidities and structural bottlenecks. The speed of the transitional adjustment of many variables to their respective equilibrium paths should therefore not be taken as a measure of the global stability properties of the modeled economy, but rather as a direct outcome of the laboratory characteristics of a macroeconomic model with continuous, well-behaved functional forms in the absence of adjustment costs. 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 postponing 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 reliance on indirect taxes has appealing outcomes in that it is easy to extract fiscal revenues, yet suffers from distortionary consequences. The current stance of the fiscal authority in Turkey clearly bears an ongoing commitment to indirect methods of collecting tax revenues. In 1996, revenues from indirect taxes reached to 65% of the aggregate tax revenues, and, in contrast, revenues from the direct income taxes barely covered the interest costs on the outstanding domestic debt. The results indicate substantial loss of potential output (about 5% in comparison to the reference path), and a significant reduction in consumer welfare (almost a 1% in comparison to the benchmark of coordinated income tax reform).

Under the indirect tax regime, our results reveal a high ratio of the stock of debt to GDP, with interest costs accounting for almost one quarter of the aggregate fiscal revenues under conditions of long-run equilibrium. With relative contraction of the GDP, the burden of the fiscal debt is severe, and the

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8. Modern macroeconomic theory provides an array of cases where one can rigorously justify the representative agent characterization of aggregate behaviour. See, for example, Deaton and Muellbauer (1980). For a counter view arguing that representative agent specification can be misleading, see Kirman (1992).



path of private consumption is significantly impeded. In terms of output impacts and the adjustment processes in the factor markets, the model results suggest a severe contraction of the industrial sectors. This negative effect originates mainly from the adjustments in the domestic price system. Under the income tax reform scenario, the transitional paths of the sectoral outputs vary. Output production increases in all non-agricultural sectors, yet in the long-run equilibrium, producer manufacturing and intermediates still fall below their pre-policy levels.

Welfare gains were computed as changes in equivalent variations. Overall, experiments based on income tax reform report positive gains in this measure, mainly as a result of the tariff elimination policy. The continued use of the distortionary indirect taxation, however, significantly reduces such potential gains, and leads to a loss of 1.0% in social welfare.

According to our results, under the analyzed patterns of fiscal adjustment together with the elimination of tariff protection, Turkish economy's trade deficits would probably increase dramatically. This would naturally require 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 our experiments, under conditions of such a darkening external environment, 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. To confront the increased fragility and riskiness in its asset markets, the indirect taxation mode of fiscal adjustment revealed a necessary premium of 6.9% in real terms, with a sizable contractionary adjustment on capital investment by -5.6%.

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## APPENDIX I

## EQUATIONS AND VARIABLES OF THE INTERTEMPORAL MODEL

## A. LIST OF EQUATIONS

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*Time-Discrete Intertemporal Utility*  
(The elasticity of intertemporal substitution is set at 1.)

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

*Intertemporal Value of Firms*  
*Within period equations (time subscript is omitted)*

$$V_{i,1} = \sum_{t=1}^{\infty} \frac{1}{\prod_{s=1}^t (1+r_s^D)^t} \left[ PV A_{i,t} (f_i(K_{i,t}, L_{i,t} - adj \cos t_{i,t}) - w_t L_{i,t} - P I_{i,t} I_{i,t}) \right]$$

$$adj \cos t_j = \phi_j \frac{I_j^2}{K_j}$$

*Armington Composite Functions*

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

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

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

*CET Functions*

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

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

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

#### Value-Added and Output Prices

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

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

#### Factor Market Equilibrium

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

$$\sum_i (1 - \alpha_i) PVA_i X_i = W\ell \cdot L_i$$

$$\sum_i L_i + LEIS = L^S$$

#### Private Demand System

$$CD_i = \frac{a_i(Y - SAV - w\ell \cdot LEIS)}{PC_i}$$

$$LEIS = \frac{\lambda(Y - SAV)}{w\ell}$$

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

$$INVD_i = \frac{\theta_{ij} PI_j I_j}{PC_i}$$

#### Household Income

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

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

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*Commodity Market Equilibrium*

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

*Government Fiscal Balances*

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

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

$$GBOR = GEXP - GREV$$

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

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

*Domestic Interest Rate*

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

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

*Trade Balance*

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

$$FBAL = FBOR + GFPA Y$$

*Dynamic Difference Equations**Euler Equation for Commodity Consumption*

$$\frac{Y_{t+1} - SAV_{t+1} - w l_{t+1} \cdot LEIS_{t+1}}{Y_t - SAV_t - w l_t \cdot LEIS_t} = \frac{1 + r_{t+1}^D}{1 + \rho}$$

*Non-Arbitrage Condition for Investment*

$$q_i = PI_{i,t} + 2 \frac{adj \cos t_{i,t}}{I_{i,t}}$$

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

*Sectoral Capital Accumulation*

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

*Private Foreign Asset Formation (debt if negative)*

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

*Government Debt*

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

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

$$GFPAY_t = -R_t^D BFG_{t-1}$$

*Terminal Conditions (Steady State Constraints)*

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

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

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

$$GBOR_{SS} = 0$$

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

*Welfare Criterion (Equivalent Variation Index)*

$$\sum_{t=1}^T \left( \frac{1}{1+\rho} \right)^t \ln [F\hat{C}_t(1+\psi)] = \sum_{t=1}^T \left( \frac{1}{1+\rho} \right)^t \ln FC_t$$

where,  $FC$  is base-year full consumption for good  $i$ . Welfare criterion therefore 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.

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## B. GLOSSARY

## 1. Parameters

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$\Lambda_i$	shift parameter in Armington function for good $i$
$\Gamma_i$	shift parameter in <i>CET</i> 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 <i>CET</i> 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 <i>CET</i> 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
$\gamma$	leisure share parameter in full consumption

## 2. Exogenous variables

$L_t^s$	labour supply
$tm_{it}$	tariff rate for $i$
$tx_{it}$	indirect tax rate for $i$
$ty_{it}$	income tax rate
$PWM_{it}$	world import price for good $i$
$PWE_{it}$	world export price for good $i$
$rF_{it}$	world interest rate

## 3. Endogenous variables

$PD_{it}$	own good price for $i$
$PX_{it}$	producer price for $i$
$PC_{it}$	composite good price for $i$
$PVA_{it}$	price of value-added for $i$
$PI_{it}$	unit price of investment quantity in sector $i$
$q_{it}$	shadow price of capital in sector $i$



$div_{it}$	dividends of sector $i$
$W_{it}$	wage rate
$Wk_{it}$	marginal product of capital in sector $i$
$L_{it}$	labour allocated to work
$LEIS_{it}$	labour allocated to leisure
$X_{it}$	output of good $i$
$C_{it}$	total absorption of composite good $i$
$D_{it}$	own good $i$
$M_{it}$	import good $i$
$E_{it}$	export good $i$
$TC_t$	aggregate private consumption
$CD_{it}$	private consumption demand for composite good $i$
$INVD_{ijt}$	investment demand for composite good $i$ , from sector $j$
$INTD_{it}$	intermediate demand for composite good $i$
$SAV_{it}$	household savings
$K_{it}$	capital stock in sector $i$
$I_{it}$	investment quantity in sector $i$
$FBOR_{it}$	new purchases of foreign assets held by the private sector
$FBAL_{it}$	trade surplus (deficit if negative)
$BF_{it}$	private foreign assets
$GREV_{it}$	government revenues
$GEXP_{it}$	government expenditures
$GBOR_{it}$	government domestic borrowing
$GFPAY_t$	interest payments on external public debt
$BPG^s_{it}$	government domestic debt
$GD_{it}$	sectoral public consumption
$\pi_t$	risk premium
$r^D_t$	domestic interest rate
$TI_i$	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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## APPENDIX 2

## DATA AND THE CALIBRATION STRATEGY.

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The data where calibration and the baserun are initiated are drawn primarily from the 1990 input-output data (SIS, 1994) and from an accompanying social accounting matrix (Köse and Yeldan, 1996). Calibration of the model involves specifying values for certain parameters based on outside estimates and deriving the remaining ones from restrictions posed by the equilibrium conditions. As in a static CGE model where calibration begins with the assumption that data obtained for the domestic economy reflect period equilibrium, we assume the Turkish economy in the model to be evolving along a balanced growth path.<sup>9</sup>

The calibration method used here is similar to that used in Diao and Somwaru (1997). For data consistency, we try to choose as few as possible exogenously determined parameters and variables. We first set the elasticity of intertemporal substitution to unity; therefore, the household time discount rate,  $\beta$ , is equalized with the world interest rate,  $r$ , for which a value of 0.04 is chosen. The Köse and Yeldan (1996) SAM data base further provides both the values of each sector's capital stock and flows. Thus, given the data on the value of total investment, including adjustment costs, it is straightforward to calculate the initial level of dividend payments ( $div = capital\ flows - total\ investment$ ). The aggregate steady-state value of the firms,  $V$ , and the marginal capital product (Tobin's  $q$ ), are then obtained from the relations,  $V = div/r$  and  $q = V/K$ . The values of the capital depreciation rate,  $\delta$  and the coefficient of the capital adjustment function,  $\phi$  must be determined consistently, given the conditions of steady-state equilibrium. We can choose either  $\phi$  or  $\delta$  first, and then calculate the other parameter from the steady-state conditions presented above. If  $\phi$  is chosen first, then  $\delta$  can be calculated from the following equation derived from the steady-state conditions:

$$\delta = \frac{q}{2P\phi} - \left[ \frac{rq - Wk}{P\phi} + \left( \frac{q}{2P\phi} \right)^2 \right]^{1/2}$$

9. The Steady State assumption, though questionable for most developing countries, is systematically adopted in applied intertemporal general equilibrium models due to its extreme convenience for calibration. For example, see Goulder and Summers (1989), Go (1994), and Mercenier and Yeldan (1996).

The quantity of aggregate investment,  $I$ , can be determined through  $I = \delta K$ . The capital adjustment costs and the price of investment,  $PI$ , then can easily be calculated.

In a dynamic general equilibrium model, the analyst is typically interested in the adjustments generated in the finite time periods in response to parametric changes of selected exogenous variables rather than the long-term intertemporal equilibriums of the economy at which all transitions to the steady state have been completed. Hence, imposition of a terminal condition becomes pertinent for a discrete time dynamic model given the presence of an out-of-steady-state transitional path for the endogenous variables. Since the so-called terminal conditions are, in fact, conditions for the steady state (see equations 15 to 18), an ideal terminal period should be chosen when a steady state is asymptotically approached. In administering the dynamic experiments, we adhered to two criteria to select the “convergence” of a steady state: first, the time horizon when 99.99% of the transitional life of the main variables is realized; second, the time period when all endogenous variables cease to change by less than 0.000 001. The model is solved in a PC using the GAMS software.

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