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Abstract: This paper presents both a review of a Computable General Equilibrium (CGE) Model that can be used to analyse the impact of fiscal policy changes on the Turkish economy and an explanation of a Benchmark data that forms the counterfactual evidence against which alternative policy scenarios can be compared. The model follows the tradition of applied general equilibrium tax models pioneered by Shoven and Whalley (1972, 1973) although its precise specification is more closely allied to the standard CGE models described in Dervis *et al* (1982). The Benchmark data set not only includes a Social Accounting Matrix but also gives avlues for the model's parameters that are required to solve the model.

Key Words: Turkey, VAT, CGE Modelling, Social Accounting Matrix, Tax Reform

JEL Classification: C68, D58, E60, H27, H30,

1. Introduction

This paper provides a technical introduction to a computable general equilibrium (CGE) tax model of the Turkish economy that is based on a Social Accounting Matrix (SAM) framework. Dervis et al (1982b) give a good survey of the CGE models that are currently in use and they provide the starting point for this model which follows the tradition of applied general equilibrium tax models pioneered by Shoven and Whalley (1972, 1973). In brief, the model presented in this paper is a one-stage static multi-sector general equilibrium model that incorporates several industries, households, goods and factors. Although our model is closely related to conventional Shoven-Whalley type general equilibrium tax models, we develop a sophisticated foreign sector in this study to provide a more appropriate model for analysing policy change in Turkey.

A number of GCE policy models have previously been formulated for the Turkish economy and these include work by Dervis *et al* (1982a), Grais, Melo, and Urata (1986), Guven (1986), Harrison, Rutherford, and Tarr (1993b), Lewis, and Urata (1983, 1984) and Yeldan (1989, 1990, 1992). They are surveyed in Karadag (1998) and consider the implications of a wide range of policy issues including the impact of trade policy and structural changes on various aspects of the performance of an economy such as income distribution and economic growth. Although the requirement for different types of policy analysis will alter the focus of the models used, most models currently in use have a similar form. In the main these are based on the pioneering work of Adelman and Robinson (1978) and Dervis *et al* (1982b). Furthermore the majority of those models that have been applied to Turkey have been concerned with a consideration of trade policies, economic growth and structural changes.

To the best of our knowledge, this study presents the first attempt to construct a CGE model of the Turkish economy that can be used to analyse fiscal policy issues. This model has been primarily designed to analyse the consequences of the approximation of Turkish VAT rates to those within the European Union in preparation for full membership of the European Union and the results of these simulations can be found in Karadag (1997), and Karadag and Westaway (1998, 1999). Whilst several models have been developed to anayse tax policy issues, only a small number of models focus on fiscal harmonisation issues. These are all concerned with the impact of tax changes on EU member states and we are unaware of any model that has been developed to study the impact on a country that is seeking membership. They include models developed by Fehr *et al* (1993, 1995), Haufler (1993), Wajsman (1992) and Whalley (1979).

The approach adopted here differs from previous models of the Turkish economy in a number of ways. A government sector is obviously included in all previous CGE models of the Turkish economy but, as tax policy issues are not the main focus of previous work, the treatment of taxes lacks the detail employed in this study. A further important difference that are a feature of tax-based CGE models concerns the treatment of the government's budgetary position following a policy change. This approach, which is firmly based on the Shoven-Whalley type applied general equilibrium tax models, follows an equal yield tax policy was not adopted by the other studies mentioned above. However, a common feature is that the government budget is balanced in the benchmark equilibrium. A further distinguishing feature of our model, which tends to be a characteristic of models which include detailed modelling of VAT, is the conversion of producer goods into consumer goods. Finally, with the exception of Guven (1986), income distribution aspects are neglected or treated in a superficial way.

The level of disaggregation is an important element of CGE modelling although to a large extent this is data-determined. In this case, the model is dissaggregated to allow for eleven producer goods, nine consumption goods and six household types. Whilst it is possible to dissaggregate further, the level of disaggregation chosen allows us to examine the impact of policy change across a wide and varied range of production goods, consumption goods and household types whilst maintaining a robust data set.

The model is defined to accommodate the different sectors and characteristics of the Social Accounting Matrix, SAM. Given the formulation of the model, the SAM is then used to calibrate the majority of model's parameters. It is worth noting at this stage that most of the data in the SAM are in expenditure/value form, i.e. they are mainly payments of the form price times quantity. When calibrating the model we follow the convention originally adopted by Harberger (1959, 1962) and assume that all prices are unity. There are exeptions to this general rule as certain payments, such as government transfer payments, do not have associated prices or quantities. The GAMS software package programme developed by Brooke, Kendrick, and Meeraus (1988) is used to calibrate and solve the model.

The remainder of the paper is organised as follows. Section 2 describes the basic structure of a general equilibrium tax model and an overview of its characteristics. A more detailed description of the component parts of the specific model employed is presented in Section 3. Sections 4 and 5 concentrate on the construction of the benchmark data set and the parameterisation methods used in solving the model.

2. The Basic Structure of the General Equilibrium Tax Model of the Turkish Economy.

The model used in this study is a medium-scale, traditional Walrasian CGE tax model that incorporates the behaviour of the four main sectors of the economy. These sectors are broadly classified into a production sector, a household sector, a government sector and a foreign sector. In order to study the impact of the simulated policy changes, the model disaggregates the economy into a range of producer goods, consumer goods and households types.

As can be seen from Table 1, the model includes 11 producer goods, 9 consumer goods, and 6 household types which are classified according to their income size and to their geographical regions. The primary factors of production namely, capital and labour, are used as inputs by industries and owned by households in different proportions. In the model labour is fully mobile, whilst capital is immobile across the sectors. The labour market is assumed to be neo-classical, with full employment and wage rate equalisation across the sectors in the model.

Table 1: Classification of Industries, Consumer Goods and Households

Production Goods	**Consumer Goods**
Agriculture	Food
Mining	Tobacco and Alcohol
Food Processing	Clothing
Textiles	Housing
Light Intermediates	House Furnishing and Appliances
Petroleum	Transportation and Communication
Basic Intermediates	Health and Personal Care
Machinery	Culture, Education and Entertainment
Electricity, Gas, Water	Other
Construction	
Services	
Household Groups	
Urban-Poor	Rural-Poor
Urban-Middle	Rural-Middle
Urban-Rich	Rural-Rich

Table 2: The Main Characteristics of the CGE Tax Model

Production	Producers are profit maximisers and cost minimisers. Cobb-Douglas production functions determine the value added by each industrial sector using both primary factors and intermediate products as inputs. Requirements for intermediate production across sectors is determined using an input-out matrix which has fixed coefficients.
Final Demand	Households maximise utility and Cobb-Douglas utility functions determine the demand for each of the consumer goods. Investment demand by origin is modelled using a fixed coefficient model. Government demand is exogenously given and modelled using fixed coefficients.
Foreign Sector	The foreign trade sector is based on a small country assumption when modelling both imports and exports. This implies that Turkey is a price taker and can not influence the world import price of products. Imports and domestically produced goods are imperfect substitutes (Armington Assumption). Domestic production is supplied both for domestic markets and for export sales according to CET (constant elasticity of transformation) functions. Foreign capital is fixed in terms of foreign currency.

The main characteristics of the CGE tax model is outlined in Table 2. Each of the 11 cost-minimising production sectors produces a single output using inputs of labour, capital and intermediate goods. Within each production sector, a Cobb-Douglas production function is used to generate the value added that is produced from these primary factors, labour and capital. In turn this value added combines in fixed proportions, with intermediate inputs from the other production sectors to produce domestic output. The demand for intermediate goods is represented by an input-output matrix which has fixed coefficients. Production also meets the demand for final goods by households, the government, firms (in the form of investment goods) and the export sector. It must be recognised that within the model consumer goods have a different aggregationfrom those which are produced by the production sectors. therefore we convert the 11 producer goods into 9 consumer goods using a transformation (or conversion) matrix.

The household sector is disaggregated into 6 separate household groups using a two-dimensional framework. The first category splits households according to their geographical location, i.e. urban or rural, whilst the second disaggregates according to three broad household income i.e. poor, middle and rich. These households derive their income from selling their endowments of labour and capital. They also receive lump-sum transfer payments from the government and transfers from abroad. Households are assumed to save a fixed proportion of their disposable income which varies according to household type. The budget constraint gives the income available for consumption after allowing for the payment of direct tax and savings. Each household group maximises a Cobb-Douglas utility function subject to this budget constraint. This procedure allows us to derive a household's demand function for each of the consumer goods which can then be aggregated to give total demand.

The level of gross investment is determined by the savings in the economy, the latter being the sum of private, public and foreign capital flows. Total savings determine the amount of funds that are available for investment. Investment demand by sector is derived from a non-nested Cobb-Douglas function. In consequence additions to capital stock by sector of destination (i.e. by the production sector in which additions to capital stock occurs) will be a fixed proportion of total savings in the economy. The model therefore assumes that investment funds are distributed amongst the different production sectors according to exogenously specified shares. This investment demand by destination has to be converted into investment demand by sector of origin (i.e. by the production sector that produces the investment goods). This is achieved through the use of a capital coefficient matrix.

The government sector is a crucial feature of this tax-based CGE model. In general terms, tax revenue is received from a wide range of taxes including income and corporate tax, value added tax, excise duties and import duties. This revenue is used to fund both income transfers to households in the form of social security payments and government expenditure on producer goods. As we have already seen income transfers vary according to household type. On the other hand, the government is assumed to consume exogenously given amounts of producer goods. Any remaining revenue is saved and used to fund investment.

The method of treatment of the major components of the Turkish tax system are summarised in Table 3. Income tax is deducted from household income. The proportion of tax deducted varies according to the household type. All other taxes are modelled as *ad valorem* taxes. The main tax on expenditure is VAT. As Turkey has introduced a European structure of VAT, it is modelled as a destination-based tax and applied to the price of consumer goods. Other indirect taxes are applied to the price of producer goods. A net tax rate is used to allow for any subsidies that might be given to a particular industry. This means that the rate of any subsidy given to a particular production sector is deducted from the tax rate that is applied to that industry. Tariffs are applied to the price of imported goods.

Table 3: A Brief Summary of the Model Treatment of Major Turkish Taxes

Tax	Model Treatment
Income tax	As a proportion of household group's income
Value Added Tax	As an *ad valorem* tax on purchases of consumer goods
Tariffs	As an *ad valorem* tax on imports
Excise Duties	As an *ad valorem* tax on the output of producer goods
Other indirect taxes, such as banking and insurance transaction tax, and motor vehicles tax	As an *ad valorem* tax on the output of producer goods

As in most CGE tax models, we assume that the government budget is balanced. Furthermore we follow Shoven and Whalley (1977) and apply equal yield tax revenue analysis. This approach means that in any simulation exercise any policy change that leads to a change in government revenue will lead to a fiscal change such that the total revenue raised from taxes remains fixed. In this particular model the rate of income tax is adjusted to achieve equal yield tax revenue. The adjustment process allows a proportional change in income tax rates for all household groups. Thus if tax revenue rises as a result of a policy change the rate of income tax is reduced and each of the six household groups will receive an equi-proportional reduction in their income tax payments and consequently an equi-proportional rise in their disposable income.

An alternative approach would be an adjustment to one or more of the elements on the expenditure side of the government's budget. Any change in tax revenue would lead therefore to an adjustment to any one or all of the following: transfer payments, government expenditure on producer goods or government savings. If the policy change leads to an increase in tax revenues, this would lead to an increase in government expenditure. The variety of potential adjustments is limitless as a smaller increase in government expenditure could be combined with a cuts in income tax such that the budget remains balanced. The choice is clearly arbitrary but in this case we choose to adjust income tax rates alone.

Several key features determine the nature of the foreign trade sector within a CGE model of this type. The demand for exports follows a downward sloping demand curve which is influenced, among other things, by the price elasticity of demand for each commodity group. Also, domestic producers supply both the domestic and export markets and domestic production is split between exports and domestic market sales according to a constant elasticity of transformation (CET) function.

Turkey is assumed to be a small country in terms of world trade. This implies that the country is a price taker and cannot influence the world prices of imports by her transactions. Foreign and domestic commodities are assumed to be imperfect substitutes and the model makes use of the Armington assumption (Armington, 1969) to determine the quantities of domestic and imported goods that are purchased. In effect their relative prices determine how domestic consumption is distributed between them. This is achieved by utilising a CES (Constant Elasticity of Substitution) function to combine domestically produced and imported goods into a composite commodity.

Domestic demand for these composite commodities comes from a variety of sources. The first is to satisfy the household demand for consumer goods. However, because the production sector has a different level of aggregation to the household sector a transformation matrix is used to convert the 11 producer goods into the 9 consumer goods. Second, the composite commodities serve as intermediate inputs for producers. Third, they combine to produce representative capital goods and thus satisfy the total demand for new capital goods given by the aggregate level of investment. Finally, they meet the final government demand for the producer goods.

Foreign economic activities includes not only trade flows but also capital flows such as net remittance inflows, net factor income and foreign borrowing. Foreign borrowing is taken to be net of amortisation and interest payments. These capital flows, which are fixed in terms of foreign currency within the model, are used to balance the external sector in the economy. However, both labour and capital are immobile internationally.

As in most CGE models, equilibrium is given by the standard Walrasian form. It is assumed that, in equilibrium, producers maximise profits, consumers maximise utility, government tax revenues equal its expenditures, demand equals supply, the external sector is in balance and the labour market is cleared. Simulations were achieved using the GAMS (General Algebraic Modelling System) software developed by Brooke, Kendrick and Meeraus (1988).

3. An Overview of the Model

In this section, we give an overview of the main relationships and equilibrium conditions that are imposed onto each sector of the model. Detailed description can be found in Karadag (1998).

3.1 The Production Sector and the Labour Market

It is assumed that each of the 11 production sectors produces a single output using constant returns to scale technology. In each sector, intermediate inputs and value added are combined by a fixed coefficient technology to generate the output. Thus, the domestic output is described by a two-level nested production structure. At the top level, a Leontief nest contains intermediate inputs and value added. At the bottom level, the value added is produced by a Cobb-Douglas nest using labour and capital stock. The labour market is assumed to be neo-classical with full employment and wage rate equalisation among the sectors. This means that labour is fully mobile between the sectors. Capital stock on the other hand is sector specific and is fixed in the short run. The production function at the first level of the industry can be written as:

$$X_i(L_i, K_i, V_{ji}) = \min\left\{\frac{1}{a_{0i}} VA_i(K_i, L_i), \frac{V_{1i}}{a_{1i}}, \ldots \frac{V_{ji}}{a_{ji}}\right\} \qquad i=1, 2, 3, \ldots 11 \qquad (1)$$

where X_i is output of production sector *i*, a_{0i} is the value-added requirement per unit of sectoral output, $VA_i(.,.)$ is value added, K_i is fixed-sectoral capital stock, L_i is labour, V_{ji} is the physical quantity of intermediate input from sector *j* to sector *i* (*j*=1,2,3, ...11 sectors), and a_{ji} represents the fixed input-output coefficients.

Value added in each sector is produced using two primary factors of production, labour, L and capital, K according to a constant returns to scale Cobb-Douglas production function :

$$VA_i = \overline{A}_i L_i^{a_i} K_i^{1-a_i} \qquad i=1,2,3, \ldots 11 \qquad (2)$$

where $\overline{A}_i$ is a constant which represents the productivity parameter in production by sector *i* and a_i is the share parameter of labour.

Based on the underlying input-output framework, it is assumed that intermediate demand V_i for each sector follows a Leontief fixed coefficient technology of the following form:

$$V_i = \sum_{j=1}^{11} a_{ij} X_j \qquad i = 1,2,3, ..11 \qquad (3)$$

As value added is combined in fixed proportions with intermediate input to produce domestic output, the price of value added can be determined from the price of final output in each sector. Thus the price of value added (PN_i) can be written as:

$$PN_i = PD_i(1 - to_i) - \sum_{j=1}^{11} a_{ij} P_j \qquad i, j = 1,2,3, \ldots 11 \qquad (4)$$

where PD_i is the domestic price of domestic sale of output in sector i, to_i is the production tax rate in sector i (given net of subsidies) and P_j is the composite price of the *j*'th good. Equation 20 below explains how this composite price is determined.

After defining the price of value added, the demand for labour can be determined. A profit maximising firm under perfect competition employs labour until the marginal product of labour is equal to the wage:

$$L_i = a_i VA_i \frac{PN_i}{w_i} \qquad i=1, 2, 3, ..., 11 \tag{5}$$

where w_i is the average wage rate earned by workers in sector *i*. Thus equation (5) defines the labour demand and the dependence of domestic supply on prices and wages is established using equations (2), (4) and (5).

The labour market clears when total labour supply, LS, equals total labour demand, LD which is given by summing the labour demand from each productive sector:

$$LS = LD \quad \text{where } LD = \sum_{i=1}^{11} L_i \qquad i=1,2,3, ...,11. \tag{6}$$

As mentioned earlier, because the classification of goods demanded by the household sector is different from that of the goods supplied by the production sectors, it is necessary to convert household demand for producer goods into demand for consumer goods. Thus, consumer goods, C_k (k=1,2,3, ..9) are derived from producer goods, Q_i (i=1,2,3, ..., 11) through the use of a fixed-coefficients *Transformation or Conversion Matrix*. Each coefficient within the transformation matrix, c_{ik}, gives the amount of producer goods *i* required to obtain one unit of consumer good *k*. For instance, a unit of the consumer good 'foodstuff' requires the output from three producer goods: agriculture, food-production and services.

The assumption of perfectly competitive markets means that, after making payment for the primary factors of production, intermediate inputs and taxes, industries will make zero profits . We also apply zero-profit conditions to production of consumer goods. Hence, the cost covering consumer good price PC_k is defined as:

$$PC_k = \sum_{i=1}^{11} c_{ik} P_i \qquad k=1,2,3, .., 9 \tag{7}$$

The final price paid by households when they buy consumer goods includes an *ad valorem* tax (VAT). According to European VAT Directives consumer goods are classified into three different VAT categories: exempt goods, low-rate goods and standard-rate goods. Each consumption goods sector will include differing combinations of goods from these different categories. Thus it is necessary to obtain a representative VAT rate for each consumption goods sector which reflects the proportions of goods from each VAT category. This is given by a weighted average of the VAT rates applicable to the goods in each consumption goods sector with the proportion of expenditure on each sector being used as weights. The representative rate of VAT applicable to each sector is given by t_V. Thus, the price including VAT paid by the consumers for good *k* is given by:

$$PT_k = PC_k(1 + tn_k) \qquad k=1,2,3, .., 9 \qquad (8)$$

where PT_k is the price of consumer good *k* (inclusive of VAT) and $_k$ is the VAT rate on consumption goods sector *k.*

3.2 The Household Sector

Households are classified according to both region and size of income using the classification reported in Household Income and Consumption Surveys (see SIS, 1990). This allows households from both the urban and the rural sectors of the economy to be further subdivided into three income groups which are given the classifications poor, middle, and rich which results in six different household groups.

Each household receives income from selling its endowments of labour and capital in the factor markets. They also receive transfer payments from government in addition to exogenous factor income remittances from abroad. Thus, the income $_h$ for household group *h* can be written as:

$$Y \quad m_1 \; LAB + m \qquad + m_3 \; REMIT \quad m_4 \; TRAN \qquad =1,2,3,.., 6. \qquad (9)$$

$m_{1h}, m_{2h}, m_{3h}, m_{4h}$ give the shares of labour income, *LAB*, capital income, *CAP*, remittances from abroad, *REMIT*, and transfers from the government sector, *TRAN*, accruing to household group *h*. It should be noted that total capital income is net of depreciation which is given by:

$$DEPR = \sum_{j=1}^{11} j_j PK_j K_j$$

where $$PK_j = \sum_{i=1}^{11} y_{ij} P_i \qquad j=1,2,3,....,11 \qquad (10)$$

In the above equations *DEPR* represents the depreciation of fixed capital which is modelled as a fixed proportion of the capital stock. The depreciation rate is j_j, PK_j is the rate of capital rent by sector *i,* and y_{ij} is the proportion of capital good *i* in sector *j*'s capital stock.

The household groups in the economy pay income tax which is deemed to be imposed on gross income at source. Disposable income or income after tax, $Y_h(1 - t_h)$, is either saved or used to buy domestically produced goods and imports. Households are assumed to save a fixed proportion of their disposable incomes and hence household savings, *HSAV,* which is translated directly into demand for investment goods, takes the form:

$$HSAV_h = [s_h Y_h (1 - t_h)] \quad h=1,2, .., 6 \qquad (11)$$

where s_h is the saving rate of household group *h*, and t_h is the average rate of income tax paid by household *h*. The income available for consumption of either domestic or foreign produced goods, YD_h, can then be written as:

$$YD_h = \left[Y_h(1-s_h)(1-t_h)\right] \qquad h=1,2, .., 6 \qquad (12)$$

We assume that the households maximise utility, which is modelled by a Cobb-Douglas utility function, subject to their budget constraint. In this case utility is obtained solely from the purchase of goods and services produced in the economy. Data limitations mean that it is not possible to model the trade-off between work and leisure and thus there is no substitution bewtween consumption and labour in the households' utility functions.

Within each consumption sector, households can purchase goods from either domestic or foreign suppliers. As explained in Section 3.3 below imported goods and domestically produced goods are seen as imperfect substitutes for each other. These are aggregated into composite goods for each of the nine consumption sectors. Thus the utility function of the household group *h* has the form:

$$U_h = \prod_{k=1}^{9} (C_k^h)^{m_k^h} \qquad h=1,2,..,.6 \qquad (13)$$

where C_k^h is consumption of the composite good *k* by household group *h*. The parameters m_k^h satisfy the properties that $m_k^h \geq 0$, and $\sum_{i=1}^{9} m_k^h = 1$. The households' demand for consumer goods can be derived by maximising equation (13) subject to the following budget constraint:

$$YD_h = \sum_{k=1}^{9} PC_k(1+t_{nk})C_k^h = \sum_{k=1}^{9} PT_k C_k^h \qquad h=1,2,.., 6 \qquad (14)$$

Hence, demand by household group *h* for individual consumer good *k* is given by:

$$C_k^h = m_k^h \frac{YD_h}{PT_k} \qquad k=1,2,3...,9 \text{ and } h=1,2,3,...,6 \qquad (15)$$

where the m_k^h weighting parameters are the Cobb-Douglas expenditure shares and YD_h is household income (after tax and savings) that is available for allocation among the 9 consumer goods.

3.3 The Foreign Sector

In applied general equilibrium models, the foreign sector is treated in a variety of ways with regard to the different assumptions made about export demand and import supply behaviour, see, for example, Whalley and Yeung (1984) and de Melo and Robinson (1989) for more details. The specification of the foreign sector in this model is similar to that used in many other CGE models that have been applied to developing countries. First, we model Turkey as a small country as far as international trade is concerned. In its treatment of foreign trade, the model adopts the commonly used Armington assumption with regard to imports and a downward-sloping, constant elasticity, export demand curve. Domestic output is supplied to the market to meet both domestic demand and export demand and a Constant Elasticity of Transformation (CET) function is employed to allocate production between export sales and domestic sales. The foreign sector must be balanced as a part of the characterisation of equilibrium. This means that the value of imports plus the net imbalance on the capital account equals the value of exports and factor incomes from abroad. This implies that Turkey always balances payments as far as international transactions are concerned.

3.3.1 Import Demand

In this part of the model we adopt the Armington assumption which states that imported and domestic goods are imperfect substitutes for any traded good. As far as imports are concerned the model therefore departs from the neo-classical assumption of perfect substitutability of tradables and the law of one price. It is assumed that, in each sector, foreign and domestic goods are combined to form a composite commodity which is traded within each production sector. This is achieved by use of a CES aggregation function with a given elasticity of substitution .

Thus the aggregation is given as:

$$Q_i = b_i \left[d_i M_i^{-r_i} + (1-d_i) D^{-1/r_i} \right]^{-1/r_i} \quad i=1,2,3,.....11 \qquad (16)$$

where Q_i, M_i and D_i are composite, imported and domestically produced commodities respectively, while b_i, d_i, and r_i are parameters within the CES function. This is analogous to considering M_i and D_i to be inputs "producing" the aggregate composite output within each production sector. Equation (16) implies that the demands for imports and domestically produced commodities become derived demands, in just the same way as the demand for factor inputs is a derived demand in a conventional production model. Households therefore choose a mix of M_i and D_i according to their relative prices.

Given the specified prices for the domestic and imported goods, the problem facing the user or buyer is mathematically equivalent to that facing a firm seeking to produce a specified amount of output at minimum cost. Minimising the cost of obtaining a "unit of utility",

$$P_i Q_i = PD_i D_i + PM_i M_i \qquad i=1,2,3,.....,11 \qquad (17)$$

subject to equation (16) where PD_i and PM_i are the domestic and imported goods prices respectively, and P_i is the "composite commodity" price yields the demand for imports of good *i* as:

$$M_i = \left(\frac{d_i}{1-d_i} \right)^{s_i} . \frac{PD_i}{PM_i} . Q_i \qquad i=1,2,3,....,11 \qquad (18)$$

where s_i, the elasticity of substitution between imported and domestic goods, is given by $s_i = \frac{1}{1+r_i}$, while d_i is the share parameter in the CES trade aggregation function.

The small country assumption implies that Turkey is a price taker on world markets and the price of imports measured in Turkish Lira (TL) is therefore given by:

$$PM_i = PW_i (1+tm_i) ER \qquad i=1,2,3,....,11 \qquad (19)$$

where PW_i is the world price of imports to sector i in US dollars and tm_i is the tariff rate on imports in sector i. The exchange rate, ER, is defined in terms of US dollars ($) per unit of Turkish Lira and is fixed in this model.

Finally, given the import demand function, the price of composite good P_i can be written as:

$$P_i = \left[d_i^{s_i} PM_i^{1-s_i} + (1-d_i)^{s_i} PD_i^{1-s_i}\right]^{1/(1-s_i)} \quad i=1,2,3,....,11 \qquad (20)$$

3.3.2. Export Demand

Classical theory assumes that a small country faces a perfectly elastic demand for its exports. However, once product differentiation is introduced, this assumption may no longer be appropriate. The assumption of product differentiation naturally gives rise to less than infinitely elastic demand functions for a country's exports. With differentiated products, while a small country may not be able to influence the world market prices with its exports, such a country may face a decreasing market share as its domestic prices rise. Accordingly, we assume downward-sloping demand curves for exports which exhibit constant elasticity .

Thus, the export demand functions have the following form:

$$E_i = E_0 \left(\frac{p_i}{PE_i}\right)^{e_i} \quad i=1,2,3,...,11 \qquad (21)$$

where E_i is the export demand for sector i's output, E_0 is a constant, p_i is a weighted average of world prices for good i, PE_i is the price of exports and e_i is the elasticity of export demand. The price of exports for sector i is defined as:

$$PE_i = \frac{PWE_i . ER}{1 + te_i} \quad i=1,2,3,...11 \qquad (22)$$

where PWE_i is the dollar price of exports and te_i is the rate of export tax.

Export supply may show a strong response to changes in domestic prices. When there is an increase in domestic prices, producers are induced to increase supply and domestic consumers to reduce their demand. This creates an excess supply onto the domestic market and there will be an increase in exports as a result of the difference between aggregate supply and domestic demand. In reality, however, exports might not increase that fast, as the domestically consumed and exported goods in the same sector may be quite different. For example, “intermediate goods” contains both traded and non-traded goods. Moreover, there might be a difference in the quality of exported goods vis-à-vis goods for domestic consumption in the same sector. Therefore, we employ a CET function given in Equation (23) to determine the allocation of domestic supply between domestically consumed XS_i and exported goods, E_i:

$$X_i = l_i \left[g_i E_i^{q_i} + (1-g_i) XS_i^{q_i}\right]^{1/q_i} \quad i=1,2,3,....,11 \qquad (23)$$

where l_i and g_i are constants, and the elasticity of transformation f_i is given by $\frac{1}{1-q_i}$. The revenue from domestic output in sector i is obtained from:

$$PX_i X_i = PD_i XS_i + PE_i E_i \qquad i=1,2,3,.....11 \tag{24}$$

where PX_i is the average output price. Maximising this revenue subject to equation (23) yields the following allocation of domestic supply between domestic sales and exports:

$$\frac{E_i}{XS_i} = \left(\frac{PE_i}{PD_i}\right)^{f_i} \left(\frac{1-g_i}{g_i}\right)^{f_i} \qquad i=1,2,3,.....11 \tag{25}$$

where $XS_i = X_i - E_i$. One should note that this gives rise to the export price PE_i diverging from the domestic price PD_i.

3.4. The Government Sector

The government enters the model through its revenue, expenditure and savings activities. It gathers revenue from various taxes and tariffs so as to finance its expenditures. The expenditure activity of the government is split into two components. We model the government as if it were a single consumer and real government expenditure on producer goods follows fixed sectoral shares on each commodity. The government also transfers exogenously given lump-sum amounts to the household sector. The difference between government revenue and government expenditure is considered as government savings. These savings are form part of total savings in the economy that are used to finance total investment.

In common with most CGE models we impose a balanced budget constraint on the government sector. An equi-yield tax revenue approach is adopted here which implies a fixed level of government expenditure. The rates of income tax are adjusted so as to avoid any budgetary imbalances that are consequent on policy changes such as changes in VAT rates that are the underlying reason for developing the model.

3.4.1 The Government Sector Revenues

The government obtains its revenue from a wide range of taxes. These include income tax, value-added tax, output taxes such as the petroleum consumption tax, banking and insurance transaction taxes and import/export tariffs. The tax rates used in the model are the effective average tax rates computed from the information supplied by the underlying Social Accounting Matrix and other government sources. We assume, given lack of information, that any tax evasion is neutral across economic agents and sectors.

Each household group h with an income Y_h faces an income tax rate t_h. Hence, the income tax revenue R_y is:

$$R_y = \sum_{h=1}^{6} t_h Y_h \tag{26}$$

The total tax revenue collected from value-added tax on consumer goods R_n is given by:

$$R_n = \sum_{k=1}^{9} tv_k PC_k C_k \qquad (27)$$

where tv_k is the rate of VAT applied to the consumption good *k*.
and the government revenue from *ad valorem* output taxes, R_o, can be written as:

$$R_o = \sum_{i=1}^{11} to_i PX_i X_i \qquad (28)$$

where to_i is the rate of all output taxes applied to the producer good *i*.

The government also receives revenue from *ad valorem* taxes on imports, R_m and on exports R_e. The final demand for imported goods is implicitly reflected in the conversion matrix and if we denote tariff rates levied on imported goods by t_m and the rate of export tax as te then the revenue from taxing imports and exports is:

$$R_m + R_e = \sum_{i=1}^{11} tm_i PWM_i M_i + \sum_{i=1}^{11} te_i PE_i E_i \qquad (29)$$

where PWM_i is the price of imports and PE_i is the price of exports from sector i in Turkish Lire.

Summing equations 26 to 29 will give the government's total revenue R from all taxes:

$$R = R_y + R_n + R_o + R_m + R_e \qquad (30)$$

3.4.2. The Government Sector Expenditures

The expenditure side of the government sector covers both transfers and real expenditures. Households receive a range of different types of transfer payment from the government. Here it is assumed that these payments are exogenously determined and that each household groups receives a fixed proportion of transfer payments made by the government, m_{4h} in line with equation (9). Thus, the total transfer payments Tr to all households from the government are:

$$Tr = \sum_{h=1}^{6} m_{4h} \overline{TRAN} \qquad h=1,2,3,..,6 \qquad (31)$$

where $\overline{TRAN}$ is the exogenously given amount of transfer payments .

It is further assumed that the government keeps its real level of expenditure on each producer good fixed. Thus, government demand for producer good *i*, G_i is:

$$G_i = w_i \overline{G} \qquad i=1,2,3,...,11 \qquad (32)$$

where w_i is the sectoral share parameters of the government consumption demand for producer goods, and $\overline{G}$ is the total government spending on producer goods and is fixed. The difference between government revenue and government expenditures forms government savings, $GOVSAV$. This forms part of the aggregate savings which are used to finance total investment in the economy. Thus:

$$GOVSAV = R - Tr - \sum_{i=1}^{11} G_i P_i \qquad i=1,2,3,...11 \tag{33}$$

where P_i is the price of a unit of output to the government in each production sector. Equation (33) therefore represents the government's budget constraint and the model requires that this must always be in balance. In effect the government uses savings to balance its budget. Any policy change can be expected to alter tax revenue received by the government and, in line with other CGE tax models an equi-tax yield policy is imposed on the model. This is effect requires the model to fix government revenue by adjusting the income tax rates paid by households.

3.5. Investment and Savings

In spite of the fact that our model is static, we must account for the investment and savings that take place during the period of analysis. When undertaking comparative static experiments it is assumed that capital stocks are fixed. Hence, investment does not add to the current capital stock, but for accounting purposes we need to specify the size and composition of investment demand. The model does not distinguish between public and private investment but rather fixed and inventory investment is pooled into a single set of sectoral investment accounts. The aggregate level of investment is determined by the available supply of savings in the economy where the latter is the sum of private, public, and foreign savings plus depreciation.

Thus, the total level of savings can be written as:

$$SAVINGS = \sum_{h=1}^{6} HSAV_h + GOVSAV + DEPR + FSAV * ER \tag{34}$$

where $FSAV$ is the level of foreign savings. This can be interpreted as the trade deficit. The level of foreign savings is given by:

$$FSAV = \sum_{i=1}^{9} PW_i M_i - \sum_{i=1}^{9} \frac{PD_i E}{ER(1+te_i)} - REMIT \tag{35}$$

In Dervis, de Melo and Robinson type models either the level of foreign savings (FSAV) or the exchange rate (ER) is endogenous. These type of models also contain an equation which exogenously fixes the aggregate price level. Thus two of these three variables are exogenously determined whilst the third is determined endogenously. In our model, both FSAV and ER are fixed and the price level is allowed to adjust endogenously. $REMIT$ are net remittances from abroad and these are also assumed fixed within the model. Equation (32) can therefore be seen as an additional equation that specifies the the level of foreign savings.

After determining the aggregate level of savings, and thus the level of investment from equation (34), we must specify how investment by sector is determined. Capital goods may be manufactured within one sector (the sector of origin) but demanded and used by another sector (the sector of destination). First, it is assumed that the total of investment funds is distributed among different sectors by exogenously specified shares. The sectoral investment function is Cobb-Douglas without any nesting. This means that investment demand by sector of destination will be a fixed proportion of total savings in the economy.

Hence the investment demand by sector of destination DK_i can be written as:

$$DK_i = \frac{b_i \left(SAVINGS - \sum_{i=1}^{11} DST_i P_i \right)}{PK_i} \qquad i=1,2,3,...,11 \qquad (36)$$

where b_i is the shares of investment by sector of destination and PK_i is the rate of capital rent. DST_i is the changes in stocks (inventory investment) and is given by:

$$DST_i = q_i X_i \qquad i=1,2,3,....11 \qquad (37)$$

where q_i is the fixed share of inventory investment by sectors in gross sectoral output. Investment by sector of destination is then transformed into investment by sector of origin through a capital composition matrix. Hence the demand for investment by the sector of origin Z_i can be obtained as:

$$Z_i = \sum_j h_{ij} DK_j \qquad i,j=1,2,3,....,11 \qquad (38)$$

where the h_{ij} are capital composition coefficients.

3.6 Equilibrium Solutions for the Model

The model outlined so far conforms closely to a standard Walrasian model, with the exception of sector-specific capital stocks. For equilibrium to be achieved the model requires that the following six conditions are satisfied.

1. The demand for the output of each sector equals its supply;
2. Producers maximise profits given the production technology;
3. Households maximise utility subject to their budget constraints;
4. Total government revenues are equal to total government spending;
5. Labour market clears, i.e., the demand for labour is equal to its supply;
6. The external sector is in balance, i.e., foreign exchange receipts are equal to foreign exchange payments.

In the model, product market equilibrium requires that sectoral supply is equal to sectoral domestic demand, or that excess demand for domestic goods is zero. Hence, the product market equilibrium for each sector is defined by:

$$Q_i - (V_i + C_i + G_i + DST_i + Z_i) = 0 \qquad i=1,2,3,...,11 \qquad (39)$$

where Q_i is the output of the composite good and C_i is the private demand for producer good *i*. It should be noted that all export demand is assumed to be for the domestically produced good rather than for the composite commodity. However, as explained earlier, household demand for consumer goods is converted into demand for production goods by using a fixed-coefficients "conversion matrix". Hence, the private demand for production goods is given:

$$C_i = \sum_{k=1}^{9} c_{ik} C_k \qquad \text{i=1,2,3,....,11} \tag{40}$$

where C_k is the demand for consumption goods.

The labour market clears when there is no excess demand for labour. Hence,

$$\sum_{i=1}^{11} LD_i - LS = 0 \qquad i\text{=1,2,3,....,11} \tag{41}$$

and the government budget constraint equilibrium condition is given by:

$$R - G - Tr - GOVSAV = 0 \tag{42}$$

Finally, the balance of payments equilibrium condition is given by:

$$\sum_{i=1}^{11} PM_i M_i - \sum_{i=1}^{11} PWE_i E_i - FSAV - \overline{REMIT} = 0 \qquad \text{i=1,2,3,...,11} \tag{43}$$

The closure rule is is the savings-driven closure described by Dervis *et.al.* (1982b) households' marginal propensities to save are fixed. Other closure rules that are not adopted here include the 'Keynesian' closure rule, in which the full employment (or labour market clearing) condition is dropped, the 'Johansen' closure rule, in which the consumption function is dropped, and the 'Kaldorian' closure rule, in which the marginal productivity condition are dropped (see Lewis (1992) for further details).

4. Construction of the SAM for the Turkish Economy

The Social Accounting Matrix or SAM is an accounting framework which encapsulates aggregate structural interrelationships amongst the various agents in an economy. It is a simple and efficient way of representing the fundamental law of the economics that for every income there is a corresponding outlay or expenditure. The SAM accounts provide the underlying data framework for CGE models with an income and expenditure account for each actor in the model. In constructing a SAM, the most important things to be noted are that it is a square matrix and that all corresponding row and column totals are equal.

Table 4 presents, in schematic form, an aggregated SAM for a national economy in which elements of the matrix are labelled according to the type of transaction they represent. The rows and columns of this square matrix are given identical labels. Summing across a row will give the expenditure for that type of transaction whilst summing down a column gives the matching income/receipts. The basic structure in this Table recognises 7 types of account which can be grouped into three categories. First, the SAM contains of a set of accounts for production activities, commodities and factors of production, the production accounts (accounts numbered 1 - 3) which represent total accounts for production within the economy. Second the SAM gives both the current and the capital accounts for institutions (numbered 5-6). Finally the table shows a distinction between the domestic economy (accounts 1 to 6) and the rest of the world or ROW for short (account 7). Thus, the SAM shows from where each account derives its receipts and how the income is distributed to the other accounts.

Table 4: An Aggregated SAM in a Schematic Form

		EXPENDITURES							
		1	2	3	4	5	6	7	8
RECEIPTS		*Production Activities*	*Commo-dities*	*Factors*	*Households*	*Government*	*Capital*	*ROW*	*Total*
1	*Production Activities*		domestic sales					exports	Total Sales
2	*Commodities*	intermedi-ate inputs			household consumption	government consumption	investment		Aggregate Demand
3	*Factors*	factor payments							Total Factor Income
4	*Households*			factor income		transfers		foreign remittances	Household Income
5	*Government*	indirect taxes	import taxes	factor taxes	direct taxes				Government Revenue
6	*Capital*				savings	savings		foreign savings	Total Savings
7	*ROW*		imports						Imports
	Totals	Total Costs	Aggregate Supply	Total Factor Income	Household Expenditures	Government Expenditures	Total Investment	Foreign Exchange Receipts	

The SAM provides a framework for reconciling an input-output table, national income accounts and other necessary data for Turkey.[1] The most recently published input-output table dates from 1990 and this provides the detailed information that forms the basis of the production accounts in the SAM. Using other sources, this input-output data was extended to incorporate information on domestic household groups consistent with the production side accounts and also to explicitly incorporate an external sector balance condition which is not present in the input-output data. As the ultimate purpose for producing the SAM was general equilibrium tax policy analysis, it is necessary to incorporate substantially more detail on taxes than exists in either the input-output table or the income and expenditure accounts. We divide indirect taxes between indirect taxes on production and indirect taxes on consumption (VAT). The former is paid by the production sectors while the latter is paid by the households when consuming consumer goods.

In constructing the SAM the system of national accounts (SNA) is followed. Under SNA it is possible to determine indirect taxes according to the agents on which they have been imposed. The SNA makes it obvous the VAT is imposed on consumer goods and paid by households. For further details see Pireddu and Dufournaud (1993,1995) and Roberts and Zolkiewski (1993).

The SAM is also extended to incorporate information on income and expenditure of the six different household types. This requires disaggregation of the accounts represented by the sector numbered as 6 in the schematic SAM above. Allowing for all levels of disaggregation by industry, consumer goods and household types results in a constructed SAM that consists of 42 separate accounts.

1 The disaggregated SAM is available from the authors if requested.

As can be seen production, as the centre of economic activity, is the most important element in the construction of a SAM. In the production account activities and commodities are separated in order to allow greater flexibility in the determination of relative prices, as well as industrial structure. The separation of the activity and commodity account is crucial in a modelling framework, as activities are assumed to consist of producers who are behaviourally distinct in the models. The separation is in recognition of the fact that there is no one-to-one correspondence between the output of a commodity and the output of an industry producing that commodity as its principal output; it is unusual for the output of an industry to fall completely within one commodity group, while conversely the total output of a commodity group may be drawn from several industries. In the SAM, industries sell their output to the commodity accounts in the proportions in which they make the different groups. Then, the commodity account distributes their outputs to industrial uses as intermediate purchases and to final users as final demands. The "commodity" account mainly corresponds to the domestic market for all products with the supplies coming from producers and imports. Note that exports are not included in the "commodity" accounts but are sold directly to the rest of the world, ROW, by producers.

The "activities" accounts (rows/columns 1 to 11) in the constructed SAM represents the accounts of the production sectors and is an aggregated input-output table for the Turkish economy . The 1990 input-output table produced by the Turkish Statistical Information Service gives inter-industry flows for 64 different industries. This is too highly disaggregated for our purpose and thus this information was aggregated into 11 broad industrial sectors. Too high a level of disaggregation of this type of information can make it it difficult to see the overall picture when undertaking policy analysis.

The activities represented by these eleven industrial sectors purchase raw materials and rent factor services in order to produce commodities. The producers receive income from sales of their output to commodity markets, from sales of exports to the rest of the world and from subsidies given by the government. The income received by producers is paid as material costs to intermediate input suppliers, as factor costs to suppliers of factors of production, and as indirect taxes as the government. The use or absorption matrix, which appears in rows/columns 12-22, is the matrix of intermediate flows. It records the commodity input into the industrial production process.

The "commodity" account (12-22) corresponds to the domestic product market, buying domestic goods from activities and imports from the rest of the world, and selling the goods to all domestic purchasers. This account is net of output tax and indirect taxes, i.e., value-added tax and specific excise duties. The entries in rows 1 to 11, columns 12 to 22 provide the mapping from activities to commodities and this set of accounts is referred to as the make matrix. This represents the matrix of production outputs by commodity groups. The make matrix is dominated by the diagonal elements because these represent the principal product output of each industry.

Unlike conventional SAMs a distinction is made between the goods and services produced (11 producer goods) and the goods and services consumed (9 consumer goods). This is because the classification of consumption goods in the data sources is quite different from that of production goods. Demand by households is defined over the class of goods that are present in the household consumption expenditure surveys while sectoral production technologies are defined taking the input-output classification into account. As the data are only available in this format, we need to construct a (11x9) transformation matrix so as to reconcile both sources of information and be able to define agents' characteristics in the underlying general equilibrium model. This transformation matrix which is given in accounts 23 to 31 permits us to convert the vector of households' consumption demands into final private consumption.

The factor accounts (32 and 33) shows payments to labour and capital, the factors of production, and the pre-tax distribution of factor income to the households in rural and urban areas. The factor accounts, thus, act as transfer accounts, channelling wages and profit income from all activities to households.

Households and government are the major economic actors in the system. These "institutions", are represented by accounts 34 to 40 and their behaviour provides much of the focus of the model. "Enterprises" do not appear as a separate institution in the accounts as they are not treated as behaviourally distinct from producers. "Households" and "government" accounts are, however, treated separately, corresponding to their very different behavioural specification in the model. Six types of households, disaggregated according to both income size and geographical regions are presented in accounts 34 to 39. The households receive factor income from firms as both labour income and capital income. In addition, they receive factor income from abroad. They also receive transfer payments from the government. Households pay direct taxes, i.e., income taxes, and then divide their disposable income between consumption and savings.

The government account (40) shows that the government receives import duties from the commodity accounts, indirect taxes from production activities and direct taxes from households. This revenue is allocated to production activities in both the form of subsidies and through expenditure on commodities. Any remaining income is saved and this savings is combined with the savings from the other sectors to form the basis of the "capital" account.

The "capital" account (41) shows receipts of funds for investment by giving the savings from the domestic and foreign sectors and expenditure on investment goods.

The final account is the foreign sector account (41) and this shows the relationship between the domestic country and rest of the world. In this SAM the account is set up to reflect the sources of foreign exchange (column 42) and its disposition (row 42). In this respect, foreign exchange receipts from exports and foreign borrowing are allocated to producers and households. Turkey either uses these receipts to buy imports or they are kept by government as increased reserves. The treatment of trade in the SAM should be consistent with the approach we shall develop in our model in this study, describing how we open the core model behaviourally to include imports and exports.

The construction of the SAM reflects the features that are given by the assumptions of the selected. Thus the SAM not only provides the underlying accounting framework but is also the source of many of the parameters of the general equilibrium model used to model the behaviour of the Turkish economy. It is essential to reconcile the benchmark data set with the general equilibrium model that has been described above. In other words, in order to calibrate parameter values for the model, we have to fit the model to the benchmark data set. However, the data set provided by the SAM is not sufficient to solve for all of the model parameters. Values for these parameters are taken from other sources.

5. The Benchmark Equilibrium Data Set

This section explains the sources and methods of constructing a consistent data set for the Turkish economy that will allow the required policy simulations. Calibration of parameter values for the model depends upon the prior construction of the benchmark equilibrium data set for a representative year. The most recent year for which input-output data is available is 1990 and thus this was the year chosen as are representative year. Since the data required for a CGE model is so comprehensive, the sources are necessarily divergent. Adjustments need to be made to ensure that all parts of the data are consistent with each other. Given that the input-output table forms the backbone of the entire modelling process all data on industry are taken to be fixed while data on household incomes and expenditures are correspondingly adjusted by using the RAS method. A consistent data set that involves the assumption of an "observable equilibrium" in which the equilibrium conditions that are imposed by the model can then be obtained.

The term RAS derives from the Row and Column Sum method. This is a method of using an initial guess of a matrix in which given row and column constraints must be met so that we can have a consistent matrix. This procedure is used to resolve inconsistencies between portions of our data set which are linked through marginal conditions. St-Hilaire and Whalley (1983 and 1987) gives further details of this approach.

5.1. Production Data

There are two primary sources of data on production within an economy and information from both sources of data are required in constructing the Benchmark data set. The information available in National Accounts is primarily macroeconomic and refers to value-added. In contrast an input-output table not only provides data on the final output of industries and their intermediate demands with regard to production but also on the relationships between the different industries within an economy. The 1990 input-output table, published in 1994 by the State Institute of Statistics (SIS), gives inter-industry transactions in millions of Turkish Lira (TL) at producer prices. It distinguishes 64 industries on the production side of the economy. This level of disaggregation is too detailed for our purpose and thus sectors were aggregated into 11 more broadly defined industrial categories. Table 5 explains how this aggregation was undertaken and hence gives the industrial classifications used to construct the SAM.

Table 5. The Sectoral Aggregation

CGE Model's 11 Sectors	Key to Sectors in the SIS Input-Output Table
1. Agriculture	1-4, 20
2. Mining	5, 7-10
3. Food Processing	11-19
4. Textiles	21-24
5. Light Intermediates	25-28, 34-35
6. Petroleum	6, 32-33
7. Basic Intermediates	28-31, 36-40
8. Machinery	41-49
9. Electricity, Gas, Water	50-51
10. Construction	52-53
11. Services	54-56

The intermediate demands are derived from the inter-industry transactions given by the Input-Output table whilst the input-output coefficients matrix for the intermediate demands among the productive sectors (or A matrix) is computed directly from the base SAM. These data rounded to 4 demical places are presented in Table 6**.** The Input-Output Table is also used to obtain figures for gross capital and labour income by industry. The value added data contains net payments to the primary factors of production plus factor taxes on production.

Table 6: Input-Output Coefficients (The A Matrix)

		Agricult	Mining	Food Pr	Textiles	Light Inter	Petrol	Basic Int	Machin	El-Gas-Water	Const	Services
		1	2	3	4	5	6	7	8	9	10	11
Agriculture	1	0.1707	0.0096	0.3453	0.0761	0.0950	0.0000	0.0006	0.0007	0.0004	0.0000	0.0108
Mining	2	0.0001	0.0023	0.0037	0.0002	0.0008	0.0001	0.0379	0.0012	0.0434	0.0207	0.0015
Food Processing	3	0.0207	0.0006	0.1591	0.0143	0.0006	0.0000	0.0044	0.0001	0.0002	0.0000	0.0124
Textiles	4	0.0015	0.0010	0.0038	0.3122	0.0064	0.0002	0.0011	0.0030	0.0010	0.0000	0.0014
Light Intermediates	5	0.0045	0.0042	0.0160	0.0060	0.2519	0.0011	0.0083	0.0273	0.0032	0.0710	0.0138
Petroleum	6	0.0238	0.0546	0.0137	0.0058	0.0200	0.4022	0.0591	0.0113	0.0881	0.0202	0.0518
Basic Intermediates	7	0.0302	0.0241	0.0188	0.0134	0.0778	0.0091	0.2782	0.3422	0.0053	0.2439	0.0097
Machinery	8	0.0040	0.0298	0.0080	0.0050	0.0084	0.0015	0.0175	0.2686	0.0416	0.0450	0.0225
Electricity, Gas and Water	9	0.0024	0.0379	0.0147	0.0247	0.0464	0.0049	0.0439	0.0164	0.0525	0.0036	0.0061
Construction	10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Services	11	0.0757	0.0712	0.1107	0.2037	0.1390	0.0409	0.1299	0.1910	0.0703	0.1481	0.1239

Employment and capital stock data are not given in an Input-Output table and thus need to be obtained form other sources. The data on labour use by industries for the base year were obtained from the Statistical Yearbook for Turkey (SIS, 1992) whilst data on capital stocks by industry were obtained from the State Planing Organisation (SPO, 1992). However, capital stock data was unavailable for 1990. We therefore took data for 1988, the most recent available and estimated the capital stocks data for the base year on the basis of a moving average of sectoral, incremental capital-output ratios. These are presented in Table 7. Economic depreciation rates were calculated from the data on capital consumption by the industries which is given in the Input-Output table.

Table 7 Production Data (TL billion unless otherwise stated)

		Intermediate Input	Indirect Taxes	Wages	Profits	Employment	Capital Stock
Production Sectors						'000 Persons	
Agriculture	1	41,808.3	-578.9	7,443.3	58,674.3	9,221	77,090.8
Mining	2	4,562.5	189.2	1,968.5	1,895.7	223	37,818.1
Food Processing	3	13,697.2	1,351.0	3,499.5	7,246.3	242	21,098.1
Textiles	4	13,607.0	684.8	3,200.6	9,088.0	833	23,997.9
Light Intermediates	5	17,788.2	424.8	2,294.3	5,320.2	460	34,908.7
Petroleum	6	35,471.9	6,907.9	420.3	5,613.2	21	30,534.9
Basic Intermediates	7	51,151.7	583.3	5,499.8	8,608.9	663	46,518.9
Machinery	8	20,627.7	2,121.5	4,548.9	8,723.0	651	27,632.9
Electricity, Gas and Water	9	9,103.0	788.8	2,434.0	3,732.4	11	83,593.6
Construction	10	0.0	987.9	13,317.9	9,956.5	904	130,181.6
Services	11	83,430.2	7,054.0	62,475.3	1,048,117.7	6,345	212,899.6

5.2. Data on Demand

The data related to household-demand side of the economy were obtained from household income and consumption expenditures surveys for 1987 (SIS, 1990). The information in these surveys has been aggregated in order to provide data for 6 different household groups. Households are first disaggregated according to the geographical area of their residence. Urban households are defined as those living in a settlements of 20,001 or more and rural households are defined as those living in a settlements of 20,000 or less. Each group is then sub-divided according to income into 3 different groups, namely, poor, middle, and rich, according to the size of their income. In this context, we consider the first 40% as being poor households, the next 40% as being middle income households and the remainder as being rich households.

The demand parameters (c_{kh}) were obtained from the shares of expenditure on good k by household group h, and adjusted in order to have market demands equal to the final private consumption column in the input-output matrix.

The survey results contain a wide variety of consumer goods categories which, as with the industrial production data, is too detailed for our purpose. We therefore use a detailed description of these categories so as to place them as accurately as possible into a more aggregated classification which consists of nine consumer goods categories. However, household expenditure on these nine consumer goods is different to that of private expenditures on the eleven producer goods. In other words, the demand parameters are given for the consumer goods and not for the output of the production sectors. This means that households do not demand agricultural products as such but rather goods that use its output, for example, bread.

A conversion matrix, Z, which links the two alternative classifications to accommodate the different expenditure category classifications in these data. VAT on consumption is deducted from the aggregate values for the nine consumer goods and then the net figures are transformed into households' demand for the productive sectors. There are 9 final consumption goods (k) and 11 sectors of production (i). Thus, each coefficient (Z_{ki}) in the conversion matrix Z gives the amount of particular producer goods needed to produce one unit of consumer good. For example, when households acquire bread, they implicitly demand the outputs from those production sectors used in the production of bread such as agriculture, food-products and the service sector. Hence, we use the Z matrix to convert expenditures on the nine consumer goods into expenditures on eleven producer goods.

Table 8 The Conversion or Z Matrix

		Consumer Good Classification								
		1	2	3	4	5	6	7	8	9
Producer Good Classification		Foodstuff	Tobacco and Alcohol	Clothing	Housing	House Furnish-ing	Health	Transfer and Commu-nications	Culture, Education and Entertain	Other
Agriculture	1	0.6382	0.0000	0.0000	0.0000	0.0000	0.0430	0.0000	0.0000	0.0621
Mining	2	0.0000	0.0000	0.0000	0.0267	0.0000	0.0000	0.0000	0.0000	0.0000
Food-proccessing	3	0.2379	0.7792	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2516
Textiles	4	0.0000	0.0000	0.4447	0.0000	0.0867	0.0000	0.0000	0.0000	0.1048

Light-Intermediates	5	0.0000	0.0000	0.0676	0.0414	0.0711	0.0000	0.0000	0.2467	0.0775
Petroleum	6	0.0000	0.0000	0.0000	0.1402	0.0000	0.0000	0.0000	0.0000	0.0000
Basic Intermediates	7	0.0000	0.0000	0.0000	0.0000	0.2076	0.4595	0.0000	0.0000	0.1249
Machinery	8	0.0000	0.0000	0.0000	0.0000	0.4061	0.0000	0.1266	0.0000	0.1220
Electricy-Gas-Water	9	0.0000	0.0000	0.0000	0.0396	0.0000	0.0445	0.0000	0.0000	0.0000
Construction	10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Services	11	0.1238	0.2208	0.4877	0.7522	0.2285	0.4530	0.8734	0.7533	0.2572
Total		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Information from household income survey results is used to allocate private income by household group. Considerable care was devoted to the allocation of the various income sources (i.e. wages and salaries, self-employment income, transfer payments, imputed rent, interest and dividends) by income range for the urban and rural households. However, adjustments to the initial endowments of the household groups were needed to match them to the value-added data given in the activity input-output matrix. The disposable income of the six household groups was estimated by deducting income tax and savings from their gross income. We derived the effective average income tax rates by household type from the data on income taxes paid by households and household disposable income. It was assumed that tax evasion is neutral across all household groups and further that this evasion is independent of the source of income.

The data for investment demand and for the final purchases by the government were derived from the 1990 input-output table. The Input-Output table also provides information on foreign sector demand including tax revenue received from industrial sectors as the payment of import duties. This information is used to provide estimates of the tariff rates that will yield the actual tax revenues received by the government.

6. Parameterisation Methods

The model needs to be calibrated before any simulations are undertaken. This means that values for the parameters within the model need to be determined. The calibration procedure employed here follows that used in other applied general equilibrium models (see Mansur and Whalley, 1984). This procedure makes the crucial assumption that the economy is in equilibrium in the base year. Thus the parameter values that are utilised must allow the model to uniquely determine the values for the variables that are given by the Benchmark data set. Some of these parameter values are taken from the applied research literature whilst others are determined by solving the model using the benchmark data set. This section explains the parameterisation methods used in determining the parameter values for this model.

The calibration procedure is based on one additional assumption namely that all data are given in value terms, i.e. they are products of prices and quantities. However, general equilibrium theory requires the separation of prices and quantities and indeed one major use of the CGE model is to determine the impact of a policy change on producer and consumer prices. The most convenient procedure, adopted by most CGE models, to determine producer prices is to choose physical factor quantities that will earn 1 Turkish Lira (TL) net of all taxes and subsidies in the benchmark equilibrium. Quantities of commodities are implicitly defined in a similar way by assuming prices of goods net of indirect taxes and tariffs to be 1 TL in the base year. Domestic prices are, therefore, used as the numeraire in the solution of the model. Consequently, the vector of factor and producer prices are all set as one in the benchmark equilibrium.

The "Replication Requirement" requires the calibration procedure to select parameter values that, in a no change policy scenario, will allow the model to yield an equilibrium set of values for the variables which duplicate the Benchmark data set. The calibration method used to derive the values for the parameters can be demonstrated with an example. Consider the Cobb-Douglas production functions in equation (2), reproduced here:

$$X_i = \overline{A}_i L_i^{a_i} \overline{K}_i^{1-a_i} \qquad i=1,2,3,.....,11$$

The corresponding first-order conditions for profit maximisation are given by:

$$w_i L_i = a_i PN_i VA_i \qquad i=1,2,3,.....,11 \qquad (45)$$

The benchmark data contains information on the value of VA_i, L_i, $\overline{K}_i$, w_i, and PN_i. Hence, this information is sufficient to derive a_i from the following equation:

$$a_i = \frac{w_i L_i}{PN_i X_i} \qquad i=1,2,3,......,11 \qquad (46)$$

Having derived a_i from equation (46), $\overline{A}_i$ i which is the productivity parameter in production of sector i can now readily computed as:

$$\overline{A}_i = \frac{VA_i}{L_i^{a_i} K_i^{1-a_i}} \qquad i=1,2,3,.......,11 \qquad (47)$$

Similar procedures are followed to derive the parameter values for the Armington functions and CET functions in the model.

Since the utility functions for the households are also of Cobb-Douglas type, we can simply take equation (15) and solve for the required share parameters, m_k^h using:

$$m_k^h = C_k^h \frac{PT_k}{YD_h} \qquad k=1,2,3...,9. \text{ and } h=1,2,3,...,6 \qquad (48)$$

This is the expenditure on good k by household $C_k^h PT_k$) divided by the total expenditure by the household. (From Equation (12) YD_h represents the income available for expenditure). The parameter values are given in Table 9.

Table 9. Share Parameters, m_k^h

		Urban Poor	Urban Middle	Urban Rich	Rural Poor	Rural Middle	Rural Rich
		1	2	3	4	5	6
Food	1	0.3781	0.2944	0.1971	0.4154	0.3690	0.3384
Tobacco-Alcohol	2	0.0535	0.0418	0.0267	0.0688	0.0517	0.0504

Clothing	3	0.0932	0.1120	0.1000	0.1179	0.1297	0.1002
Housing	4	0.1739	0.2102	0.2134	0.1173	0.0909	0.1199
House-furnishings	5	0.1512	0.1410	0.1528	0.0894	0.1740	0.1721
Health	6	0.0316	0.0335	0.0321	0.0350	0.0265	0.0250
Transport Communications	7	0.0648	0.0932	0.1984	0.0791	0.0884	0.1262
Culture, Education and Entertainment	8	0.0374	0.0449	0.0504	0.0409	0.0346	0.0333
Other	9	0.0163	0.0290	0.0292	0.0362	0.0351	0.0344

It is not possible to use this approach to solve for the trade elasticities and thus the values of these parameters need to be otained from an alternative source. Lewis and Urata (1983) have applied a general equilibrium model to an anlaysis of Turkey's balance of payments in which they estimate the required elasticities and by assuming that these elasticities are not time dependent we can use their estimates in this model.

Finally, in order to simulate the effect of policy change on VAT rates it is essential to have appropriate estimates of the VAT rates on consumer goods. The VAT rates on consumer goods are the weighted average of effective tax rates which are obtained by using unpublished information from the TMOFC and VAT legislation. Averaging is necessary because the product mix within each consumption good category contains goods which are subject to different rates of VAT. In 1990 in addition to a range of goods which are exempt from VAT, there were 4 statutory rates of VAT making five VAT categories in total. The standard rate of VAT was 10 per cent. Turkey also applied reduced rates of 1 per cent and 5 per cent in addition to a higher rate of 20 per cent. The weights used in the averaging process were the relative expenditure on each of these five VAT categories within each consumption good cateogry.

Exemptions and evasion means that the effective rates of VAT are lower than the statutory rates and we assume neutrality of tax evasion within each sector. The effective rates of VAT are constructed to ensure that VAT revenues correspond to those given in the SAM. Due to tax evasion, the effective tax rates are lower than that which would have been given if the statutory rates applied to all relevant expendtures within each category.

Table 9: Statutory and Effective VAT Rates (%)

Consumption Demand Sectors	*Statutory Tax Rates (Averaged)*	*Effective VAT rates (Averaged)*
Foodstuff	2.4	1.8
Tobacco and Alcohol	10.0	7.5
Clothing	10.3	7.8
Housing	10.0	7.5
House Furnishing and App.	10.3	7.8
Transport and Comm.	10.0	7.5
Health and Personal Care	10.3	7.8
Culture, Education and Entertainment.	3.7	2.8
Other	9.7	6.8

The "Replication Requirement" procedure requires that the parameter values that are imposed on the model is capable of replicating the Benchmark data set. The model and data can be used to consider the impact on the Turkish economy of a wide range of policy scenarios. Karadag and Westaway (1998, 1999a, 1999b) consider the potential effect of the impact of tax harmonisation with EU VAT rates that are required for full EU membership on income distribution, household welfare, producer and consumer prices and other key measures of the economic performance of the Turkish economy. As the model has a detailed fiscal structure it is particularly useful in examining other fiscal policy changes.

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