/-|-

A COMPUTABLE GENERAL EQUILIBRIUM MODEL FOR KAZAKH ECONOMY

by

AHU ZAHIDE ÖZTÜRKMEN

A dissertation submitted to the Graduate Faculty in Economics in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

1997

UMI Number: 9732958

UMI
300 North Zeeb Road
Ann Arbor, MI 48103

This manuscript has been read and accepted for the Graduate Faculty in Economics in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

4/25/97
Date

Chair of Examining Committee

4/17/97
Date

Executive Officer

Salih N. Neftçi, Ph.D.

Michael Grossman, Ph.D.

Peter Chow, Ph.D.

Supervisory Committee

THE CITY UNIVERSITY OF NEW YORK

Abstract

A COMPUTABLE GENERAL EQUILIBRIUM MODEL

FOR KAZAKHSTAN

by

Ahu Zahide Öztürkmen

Adviser: Professor Salih N. Neftçi

After the breakdown of Soviet Union, Kazakhstan declared its independence on December 16, 1991. The transition from a Soviet-type command economy to a market system started, through tentative privatizations and institutional measures. In this research I illustrate counterfactual, comparative-static simulation experiments performed using a multi-sector, Computable General Equilibrium (CGE) framework. This CGE model is then used to provide an analysis of the prospects of Kazakhstan's economic transition in the medium term. The model contains eight industries, two factors of production, and one household. The CGE model is calibrated to a Social Accounting Matrix (SAM) based on the Kazakh data for 1993. It is solved by Generalized Algebraic Modeling System (GAMS). Four different simulations are described

to explore the consequences of possible changes that the Kazakh economy may undergo during the transition period. First, the impact of higher oil revenues is analyzed. Second, the consequences of an export tax on the energy sector is examined. Third, the outcomes of imposing tariffs on the imports are investigated. Finally, the impact of a decline in labor force is observed. The simulations of the Kazakh CGE model have yielded important results. First, an oil boom will exert different effects on each sectors. The tradable sectors, mostly metallurgy and energy, will face output contraction. Clearly, some form of subsidy to the harmed sectors will be appropriate. Unless the government pays more attention to developing the competitiveness of the non-oil sectors, Kazakhstan's mineral and energy wealth may constrain the development those sectors. Second, the levying of an export tax on oil will cause a decline in both the production and the exports of this industry. Third, the imposition of tariffs on imports are necessary for both revenue and protection purposes. Finally, immigration during the transition period will reduce the labor force, which in turn will negatively effect the country's economy.

ACKNOWLEDGMENTS

I would like to express my sincere gratitude to Professor Salih N. Neftci whose support and motivation were instrumental not only to the completion of my degree but also to choosing my dissertation topic. I am also grateful to Professor Michael Grossman for his invaluable assistance and guidance at every stage of my Ph.D. studies.

I am indebted to Baydar Gürgen, Deputy Division Chief, IMF and Damitkiyen Katirova, Chief Officer of the Department of National Income Accounting in Kazakhstan for making all the information available to me.

I would also like to thank Sevin Yaraman, Güldehen Dursun, Jeff Joyce, Haruko Nagochi, Özlem Duran, Süleyman Gökçan and Karl Widerquist for their sincere friendship and continuous support throughout my five years in Ph.D.

I owe special thanks to my dearest friend, Saad Zouak for his patience and support. His mere presence has made every hardship easier to endure.

Finally, I am grateful to my family, Dr. Ayse Mudun, Dr. Arzu Öztürkmen, Dr. A. Baki Mudun, Dr. Hakan Yilmaz for giving me the inspiration to pursue my graduate study and to my mother, Neriman M. Öztürkmen whose love and support were indispensable to complete my educational journey.

Table of Contents

List of Tables

INTRODUCTION

In recent years, applied multisectoral general equilibrium models have gained a considerable acceptance as a tool for economywide policy analysis for both developed and developing countries. The way these models are constructed and the use of their solutions enable many policy-makers to focus particularly on the sector-specific policies. The input-output analysis developed by Leontief has labored the first studies of multisectoral models in the 1950s. The static version of Leontief's model deals with estimating the output level in any given industry that would satisfy the desired level of total demand for that industry's product. Motivated in particular by the command economies, these models provide a useful vehicle for calculating the sectoral output for a targeted level of final demand by means of the well-known "material balance equation".[1] These models are well suited for the centrally planned economies where the goal is to produce predetermined quantities. However, such models do not include an endogenous mechanism of choice among alternative potential scenarios, and therefore they are very much limited in their application to the other types of economies.[2] The lack of policy variables in the input-output models is the major reason for the dissatisfaction of many economists with these models. In the 1960s, with the

[1]See Leontief [1951].
[2]See Dervis, De Melo and Robinson [1982], chp. 2.

elaboration of linear programming (LP), it became possible to use optimization techniques for the purposes of policy planning. With the development of the maximization method, planners had a chance of including endogenous choice variables into their policy analyses. The LP permits policy makers the possibility of including their preference functions into their investigation. Another important feature of linear programming models, which distinguishes them from the earlier input-output models, is the use of the inequality constraints depending on the specific economy under investigation. This characteristic of the linear programming models made it possible for policy makers to determine the capacity utilization ratios and the levels of exports and imports.[3]

However, both the input-output and linear programming models have limited utility for policy analysis. The lack of endogenous prices in these models made it difficult for the policy makers to account for the market interactions. Even though these models capture the interaction among the industries and satisfy the overall budget constraint in the economy, they fail to show all the connections between the economic agents such as households, government and investors. Moreover, these models do not guarantee that the budget constraint of the individual agents of the economy will be satisfied. Another problem with these models is the linearity assumptions that yield

---

[3]See Dervis, De Melo and Robinson [1982], chp. 3.

unrealistic results, particularly in dynamic models. Despite their theoretical and practical pitfalls, input-output models remained as the point of origin for all the multisectoral models. In the 1970s, economists sought to build more realistic models which included endogenous price and quantity variables and which were based on a general equilibrium concept. The work of Johansen for the Norwegian economy is the first empirical example of a general equilibrium model that paved the way for the new type of non-linear multisectoral models.[4] These so-called "computable general equilibrium" (CGE) models, became an empirical simulation laboratory for the quantitative analyses of the effects of economic policies and external shocks on the domestic economy.

In this study, the eight-sector computable general equilibrium model for Kazakhstan is estimated, based on 1993 social accounting matrix. This CGE model is then used to provide an analysis of the prospects of Kazakhstan's economic transition in the medium term. The organization of the dissertation is as follows. Recent developments in the Kazakh economy are presented in Section 1.1 of Chapter 1. Sections 1.2 and 1.3 overview the computable general equilibrium models including the major contributions and recent developments. Section 1.4 presents the equations of the core CGE model. Section 2.1 of Chapter 2 outlines the 1993 social accounting matrix of

---

[4]See Johansen [1960].

Kazakhstan and its incorporation into the CGE model. In section 2.2, the benchmark data set for the CGE model of Kazakhstan is constructed. Section 2.3 uses the Kazakh benchmark data set to parameterize and calibrate the model. The structure of the economy for the base year is outlined in section 2.4. Chapter 3 employs the numerical model to simulate the effects of various exogenous shocks to Kazakh economy. Four different simulations are presented in this chapter. First, the impact of higher oil revenues is analyzed. Second, the consequences of an export tax on the energy sector is examined. Third, the outcomes of imposing tariffs on the imports are scrutinized. Finally, the impact of a decline in labor force is observed. Sensitivity analysis are presented in section 3.2. Some concluding comments are provided at the end of the thesis.

A note about data:

This study is the result of the three field-research trips undertaken in Almaty in the summers of 1993, 1994 and 1995. When I first decided to build a CGE model for the Kazakh economy, I faced an enormous data problem. There were no available channels that enable me to reach data sources except the Kazakh authorities. This forced me to go to Kazakhstan to gather the statistics by myself. However, when I had contacted with the authorities in the State Statistical Committee (Goskomstat), I realized that there were two main problems left. First, there were not any estimates of national accounts based on the international standards. Even though the revision attempts already started in the early 1990s, most of the figures were still based on the gross material product. Second, the existing data were not aggregated in sectoral level for all accounts. These problems, therefore, forced me not only to visit various channels in the government to get necessary figures but also to classify the sectors in the eight industry group. Besides the above problems, the non-computerized data was another great problem as I had to adjust these figures into a feasible environment. Section 2.2 explains the data handling procedures in detail.

CHAPTER 1

In this chapter, after we summarize the economic situation in Kazakhstan, we are going to analyze the computable general equilibrium models. In section 1, we present the recent developments in the Kazakh economy. In section 2, we discuss the main characteristics and uses of CGE models. Section 3 gives a brief literature review and recent developments in CGE analysis. Finally, in section 4, the equations of the core CGE model is given.

1.1 Recent Economic Situation in Kazakhstan

After the breakdown of the Soviet Union, Kazakhstan declared its independence on December 16, 1991. Having the second largest land area in the former Soviet Union, Kazakhstan is endowed with substantial natural resources-primarily oil, coal and minerals. In 1991, the transition from a Soviet type command economy to a market system started, through tentative privatizations and institutional measures.

In 1992, the government continued to push for the privatization of the economy and liberated the prices. However, strong elements of state control remained intact, including government ownership of most economic assets and the system of state procurement for such key products as grain and energy. Until November 1993, Kazakhstan stayed in the Ruble zone and experienced the effects of the monetization of the massive budget deficits that have occurred in other Ruble zone republics.

1993 was a critical year in Kazakhstan's economic history. A three-year industrial privatization program was introduced and an independent national currency, *Tenge*, was successfully introduced at the end of the year (November 1993). The republic has established two large joint ventures with Western oil companies. The main purpose of these extensive structural transformations was to end the economy's dependence on the Ruble zone. Since the introduction of its own currency, the government has renewed its commitment to fiscal discipline and economic reform. Meanwhile, uncontrolled monetary policies have kept the inflation rate high, averaging 28% per month for 1993 and accelerating towards the end of the year with the disorder caused by the introduction of the new national currency. A cumulative decline in National Income of more than 30% was observed in 1993. The newly introduced currency, the Tenge, was not stable and devalued rapidly during 1994. However, 1995 was a more successful year in terms of taking measures against hyperinflation. The central bank was successful in keeping the inflation rate at around 2 to 3 percent per month. However, the decline in output (estimated by Goskomstat 25 percent in 1994 and 8,9 percent in 1995) continued.

The economic potential of the Republic of Kazakhstan is based primarily on the abundant energy and mineral resources and vast agricultural lands. Three industrial sectors are particularly strong in Kazakhstan. The first is the energy sector that includes electricity, fuel and coal. Among the important energy resources are the Karaganda coal-field which can produce over 50 billion tons of coking coal, and the Irtysh river which is an important source of electrical energy.

The oil fields of Kazakhstan are among the largest known unexploited fields in the world. Due to the development of natural resources in the western regions of Kazakhstan, the republic had become one of the leading oil and gas producers in the former USSR. Petroleum exploration and exploitation is the main strategy pursued by the government for long-term development. Whereas the largest refineries are located in the eastern part of the country, oil production is located in the west. Because of the lack of a pipeline network, the production is exported to western Russia, while crude oil for the refineries is imported from Siberia. Therefore, to secure the implementation of the energy policy, construction of an export oil pipeline is necessary and negotiations are being conducted to that end.

Metallurgy is another leading branch of industry in Kazakhstan. Owing to their high level of quality, Kazakhstan's metallurgical products are highly competitive in the world market. Producing 70% of the former Soviet

Union's output of lead, 50% of zinc and 33% of copper, metallurgy is the key source of large capital inflows to the Republic.

The realization of the projects related to petroleum and metallurgy can give a chance to Kazakhstan to recover its economy very.

1.2 Computable General Equilibrium Models

Computable General Equilibrium models are applications of the Walrasian general equilibrium model to actually existing economies. An economy is represented by real data in order to assess particular policy options by determining production and demand parameters. These alternative policies are included into the model to compute the so-called "counter-factual equilibria". The outcomes of these policies, then, are evaluated by comparing the new equilibria with the original solution of the model. This gives a flexibility to many economists to see the possible effects of a given policy, both quantitatively as well as qualitatively.

The model takes into account price mechanisms and interactions in the good, factors, and foreign exchange markets, and solves the problem of overall equilibrium through the demand pattern, production structure, and incomes of various groups employed in the economy.

Unlike an input-output model, a CGE model depicts a larger picture of the economy. It contains highly nonlinear functions, bringing together the neoclassical substitutability in production and demand with the system of market prices, and portrays a complete specification of the income flows in the economy.

CGE models have been criticized on several accounts, especially for (i) limiting the analysis to the real sectors of the economy only, and (ii) for not accounting for the use of unemployed resources.

Regarding the first criticism, it must be remembered that advocates of the CGE theory do not make a claim as to the insignificance of monetary phenomena. It is rather that the unnecessary combination of micro and macroeconomics only makes more difficult the analysis of specific problems, without adding much to our understanding of them.

As to the other criticism, it suffices to say that it is more convenient to understand the fluctuations in the economy first under the perfect market assumption, and only then to introduce market failures into the model.

Since there are no rival models which overcome these criticisms while maintaining the flexibility of a general equilibrium model, CGE analysis will continue to be applied in policy analysis.

1.3 Major Contributions to the CGE Analysis

CGE analysis has progressed quite rapidly since the pioneering work of Johansen [1960]. In his multisectoral study, Johansen, applied the general equilibrium model to the Norwegian economy. He reduced the highly non-linear model to a class of log-linear equations and then solved it by matrix inversion. His model presents distinctive features in multisectoral analysis. In particular, he introduced demand and production functions that depended on endogenous relative prices. This approach does not only develops Leontief's interindustry relations by introducing endogenous variables, but it also accommodates all the agents of the economy in a general equilibrium framework.

In addition to Johansen's method of linearizing the CGE model and solving it by simple matrix inversion, there are other solution techniques in the literature to execute the CGE models.[5] First, based on the fixed-point algorithm pioneered by Herbert Scarf [1973], a CGE model can be solved by finding a fixed point in a mapping of prices to prices through excess demand equations. Second, the solution of CGE model can be formulated by finding the shadow prices that can be interpreted as market price. Finally, it is possible to treat a CGE model as a system of non-linear algebraic equations directly solved by different numerical techniques.

After the elaboration of general equilibrium computational techniques by Scarf [1973], most of the existing literature on computable general

[5]For describing the general approach of using programming techniques to solve CGE models see Ginsburgh and Walebroeck [1981].

equilibrium models focus explaining specific issues for both developed and developing countries. The most significant contributions are made in the areas of taxation, income distribution and international trade.

The first group of existing models deals with the issues of taxation and they apply mostly to developed countries. The work of Harberger [1962, 1966] is the first general equilibrium model for taxation. In his one-consumer, two-sector model, Harberger examines the interindustry distortion due to the corporate income tax for the United States between 1953-59. Shoven and Whalley [1972] have elaborated Harberger's model by including disaggregated consumer groups and sectors in order to examine large scale changes in corporate tax. Further major contributions in the area of taxation have been provided by Feldstein and Slemrod [1980] and Ballentine and McLure [1980], among others. They analyzed the interaction between taxation and financial behavior for developed countries.

In the late 1970s, CGE modeling was directed toward analyzing income distribution issues of developing countries. The Adelman-Robinson model of Korea is the first effort to examine the distribution of income in a CGE setting [1978], followed by the Ahluwalia-Lysy [1979] model for Malaysia and Lysy-Taylor [1980] model for Brazil. These models focus on the distribution of income among the various socioeconomic groups.

Dervis, de Melo and Robinson's "General Equilibrium Models for Development Policy" [1982] is a major contribution to the CGE theory for developing countries. In this work, the authors discuss how distributional phenomena can be included in the CGE models for developing countries, and also how international trade in a multisectoral setting can be treated within a CGE framework. The main significance of this work comes from addressing the issue of incorporating trade and international capital flows to the development policy in developing economies.

This model is distinguished from the standard "neoclassical" CGE models in its attempt to take into account the "structuralist" features of developing countries. Even though they remained within the theoretical framework of the neoclassical models, they extended it by defining substitution elasticities for a group of significant functions. The introduction of trade-substitution and export-demand elasticities brought about a degree of flexibility in place of the rigid neoclassical assumptions of perfect substitution and perfect complementarity.

In the late 1980s country applications of the CGE models have been more widely used, and the discussion now shifted to the issue of incorporating monetary issues within the CGE framework. The most significant contributions in this area have been made by Robinson and Tyson [1984] and Bourguignon, Branson, and de Melo [1988].

1.4 The Model

The groundwork of most of the CGE models applied to developed countries follows the Walrasian paradigm. On the other hand, in applications to developing countries specific structuralist characteristics have allowed the model builders to achieve more realistic approach. The model presented in this paper capitalizes on the contribution provided by Dervis, de Melo, and Robinson [1982]. It follows the paper "The 'Dutch Disease' in a Developing County: Oil Reserves in Cameroon." by Benjamin, N.C., S. Deverajan and R.J. Weiner [1989].

The economy analyzed here is composed of three types of markets; labor, output and foreign exchange. It is assumed that these three sets of markets all "clear" which means that the excess-demand equations of labor, output and foreign exchange must all equal to zero at equilibrium. The solution problem is to find a set of accounting wages, product prices and an exchange rate such that the three sets of excess-demand equations are simultaneously satisfied.

Upper case letters are used for endogenous variables, while lower case presents the parameters and exogenous variables. Indices are used to show the sectors (i and j) and primary factors of production (f).

First set of equations are quantity equations which determine the supply side of the model. The production function is nested. It is based on a two-level CES formulation. Output is a fixed coefficients function of real value added and intermediate inputs. The real value added is a Cobb-Douglas function of capital and labor:

(1) $$X_i = a_i^D \prod_f FD_{if}^{\alpha_{if}}$$

where X_i is the domestic output of sector i;

FD_{if} is the factor demands;

α_{if} is the Cobb-Douglas function share parameter; and

a_i^D is the Cobb-Douglas function shift parameter. Note that the capital input is a fixed coefficients of aggregate capital goods (FD_{i1} =capital stock).

Primary factor demand conditions are represented by the following equations:

(2) $$AFP_f \cdot wf_{if} \cdot FD_{if} = \alpha_{if} \cdot P_i^v \cdot X_i$$

where AFP_f is the average factor price;

P_i^v is the value added price; and

wf_{if} is the proportionality ratio of sectoral factor rate to average factor rate. Average rental or wage (AFP_f) is the same for all sectors. Literature shows that in developing countries factor prices vary over the sectors. The sector-specific parameter, wf_{if}, for capital and labor measures the extent to which the average return is smaller or larger than the value of the marginal product.

Intermediate input demand for each sector is presented by fixed input-output coefficient and the sectoral domestic output:

(3) $$ID_i = \sum_j a_{ij} \cdot X_j$$

where ID_i is the intermediate input demand; and

a_{ij} is the input-output coefficients.

Total domestic production is supplied to domestic or foreign markets. It is defined as the CET transformation functions of exports and domestic sales:

(4) $$X_i = a_i^T\left[\gamma_i E_i^{\rho_i} + (1-\gamma_i) D_i^{\rho_i}\right]^{1/\rho_i}$$

where X_i is the domestic output;

E_i is the exports;

D_i is the domestic sales of domestic output;

a_i^T is the CET function shift parameter;

γ_i is the CET function share parameter; and

ρ_i is the CET function exponent.

Export supply function depends on the relative prices $\left(P_i^E / P_i^D\right)$:

(5) $$E_i = D_i\left[P_i^E(1-\gamma_i)/P_i^D \cdot \gamma_i\right]^{1/(\rho_i-1)}$$

where P_i^E is the domestic price of exports; and

P_i^D is the domestic sales price.

The model incorporates the small country assumption. However, Kazakhstan country is assumed to have a market power in the energy sectors. For these sectors, downward sloping world demand curve is assumed. The following equation gives the world export demand function for the energy sectors:

(6) $$E_i = exp_i\left[PW_i^E / pwes_i\right]^{1/\eta_i}$$

where exp_i is the export demand shift parameter;

$pwes_i$ is the world price of export substitutes;

PW_i^E is the world price of exports; and

η_i is the export demand price elasticity.

The model assumes the imperfect substitutability between imported and domestically produced goods which allows simultaneous export and imports at the sectoral level. The demand for composite commodity is determined by CES aggregation functions of domestic products and imports:

(7) $$Q_i = a_i^C\left[\delta_i M_i^{-\varphi_i} + (1-\delta_i) D_i^{-\varphi_i}\right]^{-1/\varphi_i}$$

where M_i is the imports;

a_i^C is the CES function shift parameter;

δ_i is the CES function share parameter; and

φ_i is the CES function exponent.

Note that $1/(1+\varphi) = \sigma$ is the trade substitution elasticity which determines the responsiveness of domestic demand to changes in the relative price of imported goods caused by any exogenous event.

The first order conditions of cost minimization yield the corresponding import demand functions which depend on the relative prices (P^D/P^M):

(8) $$\frac{M_i}{D_i} = \left[\frac{P_i^D \cdot \delta_i}{P_i^M \cdot (1-\delta_i)} \right]^{1/1+\varphi_i}$$

where P_i^M is the domestic price of imports. The major implication of export and import functions is that the ratios of exports and imports to domestic sales at the sectoral level depend only on relative prices.

The second set of equations define the prices in the model. There are six different prices. Domestic price of imports is the tariff inclusive world price of import substitutes times the exchange rate:

(9) $$P_i^M = pw_i^M \cdot (1+t_i^M) \cdot ER$$

where pw_i^M is the world price of imports;

t_i^M is the sectoral tariff rates; and

ER is the exchange rate.

The exchange rate used in the model is the price of a dollar in terms of the local currency. The world prices are exogenous for the energy sectors.

Similarly, the domestic price of exports is the tax exclusive world price times the exchange rate:

(10) $$P_i^E = PW_i^E\left(1-t_i^E\right)\cdot ER$$

where PW_i^E is the world price of exports; and

t_i^E is the sectoral export tax rates.

The price of composite commodity is the average of a domestic import price and a domestic good price:

(11) $$P_i^Q \cdot Q_i = \left(P_i^D \cdot D_i + P_i^M \cdot M_i\right)$$

where P_i^Q is the price of composite goodQ.

The price of domestic output is the average of an export price and a domestic goods price:

(12) $$P_i^X \cdot X_i = \left(P_i^D \cdot D_i + P_i^E \cdot E_i\right)$$

where P_i^X is the price of domestic output.

Sectoral "net prices" or the price of value added is the tax exclusive output price minus the unit cost of intermediate inputs. Unit cost of intermediate inputs is the price of the composite commodity times the fixed input-output coefficients, a_{ji}. These coefficients can easily be calculated from the input-output table.

(13) $$P_i^V = P_i^X(1-t_i^X) - \sum_i P_j^Q \cdot a_{ji}$$

where P_i^V is the value added price; and

t_i^X is the indirect tax rate.

The price of a unit capital installed in sector i is sectorally differentiated. This is the assumption of heterogeneous capital usage in different sectors. It is assumed that one unit of capital employed in each sector has different composition. Capital coefficient matrix contains the sectoral composition of capital goods by sector of origin in its columns.

(14) $$P_i^K = \sum_j P_j^Q \cdot b_{ji}$$

where P_i^K is the price of a unit of capital in each sector; and

b_{ji} is the amount of capital good from sector i which is necessary to create one unit of capital in each investing sector j. Note that the sum of b_{ji} in each sector j is unity.

Finally, GDP deflator is used as an aggregate price index (PINDEX). It is the nominal GDP (GDPVA) divided by real GDP (RGDP).

(15) $$PINDEX = GDPVA/RGDP$$

The price index is essential since the model can only determine the relative prices.

Third set of equations describe the flow of income from value added to institutions. Factor income equations are in the form of

(16) $$Y^F = \sum_i AFP_f \cdot FD_{if} \cdot wf_{if}$$

where Y^F is the factor income.

Households receive the factor income and pay depreciation out of it. Therefore, the household income is factor income minus depreciation.

(17) $$Y^H = Y^F - DEPREC$$

where Y^H is the household income; and

DEPREC is the financial depreciation.

Similarly, government receive income from indirect taxes, tariffs, household taxes and export taxes. Indirect tax revenue can be calculated by the following equation:

(18) $$INTAX = \sum_i P_i^X \cdot X_i \cdot t_i^X$$

where INTAX is the total indirect tax revenue; and

t_i^X is the indirect tax rate.

Tariff revenue is defined by the following equation:

(19) $$TARIFF = \sum_i pw_i^M \cdot M_i \cdot t_i^M \cdot ER$$

where TARIFF is the total tariff revenue; and

t_i^M is the tariff rate.

Income tax imposed on households is given by the following equation:

(20) $$HHTAX = Y^H \cdot t^H$$

where HHTAX is the total income tax revenue; and

t^H is the income tax rate which is imposed on households.

Export tax revenue can be calculated by the following equation:

(21) $$EXPTAX = \sum_i PW_i^E \cdot E_i \cdot t_i^E \cdot ER$$

where EXPTAX is the total export taxes; and

t_i^E is the export tax rate.

Government revenue equals to the sum of indirect tax revenue, tariffs, income taxes and export taxes:

(22) $$GR = INTAX + TARIFF + HHTAX + EXPTAX$$

where GR is the government revenue.

Savings are determined by household savings, government savings, financial depreciation and foreign savings. Household savings is determined by the fixed propensity of savings rate.

(23) $$HHSAV = Y^H(1-t^H) \cdot mps$$

where HHSAV is the total household savings; and

mps is the fixed saving propensities.

Government savings are given by the difference between government revenue and consumption.

(24) $$GSAV = GR - \sum_i P_i^Q \cdot GC_i$$

where GSAV is the government savings ; and

GC_i is the government consumption.

Finally, total savings are defined as the sum of domestic and foreign savings:

(25) $$SAVING = HHSAV + GSAV + DEPREC + FSAV \cdot ER$$

where SAVING is the total savings;

FSAV is the foreign savings; and

DEPREC is the depreciation.

Foreign savings are converted to the domestic currency by the exchange rate Domestic savings should include financial depreciation (DEPREC) which is defined by the following equation:

(26) $$DEPREC = \sum_i depr_i \cdot P_i^K \cdot FD_{il}$$

where $depr_i$ is depreciation rate ; and

FD_{il} is capital stock.

Next set of equations are the expenditure equations which determine the demand for goods by the different actors. Fixed expenditure shares are used to determine the private consumption :

(27) $$P_i^Q \cdot C_i = \beta_i^H \cdot Y^H \cdot (1 - mps) \cdot (1 - t^H)$$

where C_i is the private consumption or household consumption; and

β_i^H is the fixed expenditure shares of households;

Similarly, fixed shares of aggregate real spending are used to determine the government demand:

(28) $G_i = \beta_i^G \cdot rc$

where G_i is the government's demand for final goods;

β_i^G is the fixed expenditure shares of government; and

rc is the real government consumption.

Change in stocks or inventory demand is determined by the fixed shares of sectoral production.

(29) $IVD_i = \varepsilon_i \cdot X_i$

where IVD_i is the demand for inventories or change in the stock; and

ε_i is the fixed shares of inventories to the sectoral production.

Investment is exogenous. Once inventory demands are known, aggregate fixed investment can easily be obtained from the difference between total investment and inventory accumulation.

(30) $FIXIN = INVEST - \sum_i P_i^Q \cdot IVD_i$

where FIXIN is the aggregate fixed capital investment ; and

INVEST is the total investment.

Real sectoral investment of destination is derived from aggregate fixed investment by using fixed nominal shares:

(31) $$P_i^K \cdot RINV_i = insh_i \cdot FIXIN$$

where P_i^K is the price of capital;

$RINV_i$ is the real sectoral investment; and

$insh_i$ is the investment destination shares.

Note that the sum of investment destination shares over all sectors equal to one.

Investment should be translated into demand for capital goods. The capital composition matrix (b_{ji}) is used to translate investment by sector of destination into demand for capital goods by sector of origin:

(32) $$INV_i = \sum_j b_{ji} \cdot RINV_j$$

where INV_i is the demand for capital goods.

Nominal and real gross domestic products are defined to calculate the GDP deflator. Whereas nominal GDP is defined from the value added side, real GDP is defined from the expenditure side.

(33) $$GDPVA = \sum_i P_i^V \cdot X_i + INTAX + TARIFF + EXPTAX$$

(34) $$RGDP = \sum_i \left(CD_i + GD_i + IVD_i + INV_i + E_i - pw_i^M \cdot M_i \cdot ER\right)$$

where GDPVA and RGDP are nominal and real gross domestic products respectively. In equation (34), imports are determined in the world prices.

Finally, the equations for market clearing conditions and macroeconomic closure complete the model. Since there are three markets, namely output, factor and foreign markets, zero excess demand conditions should be satisfied by all three markets. These equations are simply the constraints in the general equilibrium system. Prices adjust to clear all the markets.

Market clearing equilibrium in the product markets states that, the sectoral supply of composite commodities must equal demand:

(35) $$Q_i = ID_i + CD_i + GD_i + IVD_i + INV_i$$

The equilibrium in factor markets are determined by the following equation:

(36) $$fs_f = \sum_i FD_{if}$$

where fs_f is the supplies of primary factors, capital and labor. They are fixed exogenously. The average factor prices, AFP_f, clear the factor markets equating the total factor demand and supply.

Ultimately, macroeconomic equilibrium conditions should be presented. Market clearing conditions for foreign markets are given in the simplest form. Foreign savings are the difference between total imports and total exports.

(37) $$FSAV = pw_i^M \cdot M_i - PW_i^E \cdot E_i$$

With exogenous foreign savings, exchange rate is the equilibrating variable for this equation.

For final macroclosure it is assumed that aggregate investment is the endogenous sum of the separate savings components. In other words, the model is a "savings driven" model, which is known as "neoclassical" rather than "Keynesian" in the CGE literature. Equation (38) reflects this macroclosure of the model: Aggregate savings equal aggregate investment.

(38) $$SAVING = INVEST$$

The number of equations is one more than the number of endogenous variables in the model. This does not effect the solution of the model since Walras' Law is satisfied.

CHAPTER 2

In this chapter, aggregate social accounting matrix and the benchmark data set for Kazakhstan are presented based on 1993 figures. Calibration procedure is used to estimate the parameters of the model.

Construction of the social accounting matrix is presented in Section 1. In this section, it is also discussed how the social accounting matrix is corporated in the model. Section 2 describes the benchmark data set used in the model. In Section 3, the parameters of the model is estimated by calibrating the model based on the 1993 Kazakh data. The details of the sectoral structure are presented in Section 4.

2.1 CGE Models and Social Accounting Matrix

A well-established data is necessary for any CGE model to capture the effects of the policy in each individual market. An input-output table shows the inter-industry dependence in the economy. The main idea in an input-output table is that the output of any industry is needed as an input in other industries, or for that industry itself. It shows all the interindustry transactions, but it does not give the overall picture of the economy.

Social accounting matrix, on the other hand, (SAM) is a balanced matrix which provides a picture of a market economy for a given year. It is a starting point for establishing the benchmark data for any CGE model. A SAM is the integration of input-output table and national income accounts. It does not only represent the inter-industry flows but also includes all the transactions in the economy.

National income accounts provide data which furnish the SAM. It simply represents the main idea in the economics theory: total income is equal to aggregate expenditures. The distinction between "activities" and "commodities" accounts is another feature of the SAM and used by many CGE model builders. "Activities" represents the producing sectors. "Commodities", on the other hand, is the absorption which is the combination of domestic supply with imports.

Table 2.1 presents the social accounting matrix of Kazakhstan for 1993. There are seven different actors in this table. Note that each cell shows the transactions between the two actors in millions of the nation's currency: *Tenge*.

Expenditures on inputs into the production process are shown in the *activity column.* These are expenditures on intermediate inputs, on value added, and on indirect taxes. The entry on intermediate inputs (31356.8) is the aggregation of interindustry flows in the input-output table. Value added (24631.1) is the aggregation of factor inputs by labor and capital. Indirect taxes (2323.5) are the other expenditures in the production process. They are

Table 2.1: A Social Accounting Matrix for Kazakhstan, 1993
(million Tenge)

RECEIPTS	*EXPENDITURES* Activities	Commodities	Value added	Households	Government	Capital account	World	Total receipts
Activities		58311.4						58311.4
Commodities	31356.8			15724.1	3993.0	8817.4	10470.0	70361.3
Value added	24631.1							24631.1
Households			23125.2					23125.2
Government	2323.5			5526.6				7850.1
Capital account			1505.9	1874.5	3857.1			7237.5
World		12049.9				-1579.9		10470.0
Total expenditures	58311.4	70361.3	24631.1	23125.2	7850.1	7237.5	10470.0	

received by the government, therefore the total of indirect taxes is entered into the government account.

The sum of input expenditures in the activity column shows the total cost which should equal gross output sales (58311.4). The *commodity column* contains purchases of domestic products from the activity account and purchases from the rest of the world. Total absorption (70361.5) is the sum of domestic commodity supplies (58311.4) and imports (12049.9). Most of the SAMs also contain the tariffs and export taxes which should be shown in government-commodities account. However, there are no explicit tariff and export tax in Kazakh SAM for the base year, 1993. Therefore, trade taxes are assumed zero in the base year.

As mentioned above, value added account receives 24631.1 millions of Tenge from activities which in turn in *value added column* is distributed to the households as income (23125.2) and to the capital account as depreciation (1505.9). The sum of households expenditures on commodities (15724.1), household income tax (5526.6) and household savings (1874.5) is the household income which shows the total of ***households column.***

Similarly, in the government column, the government receives income from both indirect taxes and household income taxes, and spends it on commodities (3993.0) and savings (3857.1). The *capital account* column includes total investment (8817.4) and balance of payments (-1579.9). It also shows the national accounts identity, total savings equal to investment (7237.5). Note that the balance of payments is in the simplest form that is balance of trade. Finally, exports are recorded to the commodities expenditure the *world* column (10470.0).

2.2 Constructing the Benchmark Data Set for Kazakhstan

For any computable general equilibrium model, consistent data set plays a major role as a starting point. Consistency refers to a data set that satisfies the equilibrium conditions for the given general equilibrium model. Demands should equal supplies for all commodities, non-positive profits are made in all industries, incomes and expenditures must be consistent with the budget constraints and the economy should be in an external balance.

A social accounting matrix which satisfies these conditions is not easily produced from the raw data. Since data are gathered from various institutions, inconsistencies arise in the data set. Some adjustments are necessary to construct a consistent benchmark equilibrium. These adjustments are substantial particularly for Kazakhstan due to the transition in its economic and political structure.

For purpose of national income accounting, Kazakhstan State Statistical Committee*(Goskomstat)* had a different classification system. Income was determined to be produced only by "productive" activities and the estimates of value added in the economy (Gross Material Product or Gross Social Product) are limited only to productive activities. In 1992, statistical institutions have started to collect new data in order to switch to the System of National Accounts (SNA). 1993 was the first year when such standard data were available.

The level of aggregation plays a major role for any economy-wide policy analysis. The sectoral classification scheme used by the statistical authorities are presented in Table A1 in Appendix A. Table A2 shows the classification in the input-output table. Non-productive activities are not included in the input-output table. The sectoral classification scheme of the Kazakh CGE model is given in Table A3. Given the availability of data, the sectors are aggregated under the eight sectors. These sectors are chosen to reflect the priorities of the transition to a free market plan that the Kazakh government intends. For the purpose of the analysis in this dissertation, of the eight sectors in the model, electricity and fuel (including coal) are referred as energy while manufacturing sectors include mainly the sectors of chemicals, machinery and metal works, sawmill and lumber, building materials (including glass and ceramic), textile and food.

Furthermore, there are some discrepancies in national accounts. Household expenditure figures are inconsistent with production-side; totals do not match. In addition, the foreign trade data hardly exist for Kazakhstan. The figures which are estimated by the *State Statistical Committee* originate from different sources and show only the net exports with the former Soviet Union (FSU) countries. *State Committee on Statistics and Analysis of Republic of Kazakhstan* publishes quarterly "Statistical Bulletin" which contains the exports and imports of only the main commodities. These commodities and correspondent sectors are presented in Appendix A, Table A4.

Hence, in constructing benchmark data set for the Kazakh CGE model, several modifications were performed. First, it was assumed that the nonpublished sectors have small volume of international trade so that the trade transactions of these sectors were suppressed in the model. Because of data problems associated with them, the products of these sectors were treated as non-tradable goods. The input-output table was enlarged by calculating nonproductive activities residually. Final demands and value added accounts were added to obtain the Social Accounting Matrix.

A Social Accounting Matrix is called balanced if the row total equal to column totals. The Kazakh SAM is balanced by minimizing the sum of deviations of the residuals for each account with the constraint of the row and column totals' identity.[1] This was necessary to ensure the balanced uniformity between inconsistent data sets. At the end, the benchmark data set was

---

[1]For a discussion of balancing SAMs with non-linear programming, see Zenios, Drud, and Mulvey [1986].

generated in which all equilibrium conditions of the model are satisfied.

2.3 Calibration of Parameters in the model

In order to solve the model, it is necessary to define the value of all the parameters appearing in the various equations. The traditional econometric methods could be used. However, estimating the set of parameters econometrically even with satisfactory data set is usually frustrating. The popular procedure used by many CGE modelers is "calibration" rather than econometrics methods. With extraneous production and trade elasticities, calibration computes the parameters of the model utilizing the information in the Social Accounting Matrix. The values in the SAM are presented in market prices. Assuming all the prices are unitary in the base year, these values can be referred as the quantities. This is a convenient assumption which is also used in the Kazakh CGE model.

The fundamental assumption made in calibration is that the economy is in equilibrium in a particular year. Once the elasticity values are externally given to the model, using the observed equilibrium in SAM, it is possible to solve the model for parameters and exogenous variables so that the CGE model solution precisely reproduces the economy given in the SAM. After the model is calibrated to the base year, with the observed equilibrium it can be used as an empirical simulation laboratory for analyzing the effects of external shocks on the domestic economy.

The parameters to be calibrated in the model are sectoral shares, factor income proportionality constants, tax and saving rates and finally the production and trade aggregation functions.

Sectoral Shares

The first set of parameters to be calibrated determine the sectoral composition of various categories of demand, including:

- fixed expenditure shares of household to determine the private consumption: (β_i^H)
- fixed expenditure shares of government's demand for final goods: (β_i^G)
- input-output coefficients to determine intermediate input demand: (a_{ji})
- investment destination shares to determine the sectoral investment allocation: $(insh_i)$
- fixed shares of inventories to determine the demand for inventories: (ε_i)
- capital composition matrix to determine the demand for capital goods: (b_{ji})

The household consumption demands are determined by the fixed expenditure shares (β_i^H) which can easily obtained from the SAM. The expenditure shares are the fraction of household's total expenditure which is spent on commodity i. Thus the shares can be calculated directly:

$$\beta_i^H = C_i \Big/ \sum_i C_i$$

Note that what is shown in Table 2.1 is the aggregate value of the household demand, more precisely, $\sum_{i=1}^{8} C_i$.

Similarly, fixed expenditure shares of government's demand for final goods (β_i^G) can be calculated as:

$$\beta_i^G = G_i \Big/ \sum_i G_i$$

Intermediate goods are determined by the fixed input-output coefficients (a_{ij}) which can be calculated directly from input-output table as:

$$a_{ij} = \frac{ID_{ij}}{X_i}$$

where ID_{ij} is defined as the flow of intermediate goods from sector i to sector j.[2]

The fixed investment destination shares $(insh_i)$ for the sectoral investment allocation is the ratio of nominal sectoral investment to the nominal aggregate fixed capital investment.

---

[2]For a discussion of computation of input-output coefficients see Leontief [1951] and Dervis, de Melo and Robinson [1982, chapter 2].

$$insh_i = \frac{NINV_i}{FIXIN}$$

where $NINV_i$ is the nominal sectoral investment. In the model, real sectoral investment $RINV_i$ is given in equation (31).[3]

Similarly, inventory investment ratios (ε_i) to the sectoral production are easily calculated from the SAM as:

$$\varepsilon_i = \frac{IVD_i}{X_i}$$

Finally, the elements of the capital composition matrix (b_{ji}) are needed to determine the demand for capital goods. Given the absence of data on sectoral aggregate capital stocks in Kazakhstan, estimating the capital coefficients matrix that describes the composition of capital is infeasible. It could have been assumed that capital investment in all sectors has the same structure as average investment, but this would be very unrealistic. Instead, the capital composition matrix has been taken directly from previous studies of developing countries, particularly the World Bank CGE model for Yugoslaiva[1983] and adjusted with the help of the authorities in Goskomstat. Note that in the model, β_i^H, β_i^G, a_{ij}, and b_{ji} are defined in real terms.

[3]Note that, $P_i^K \cdot RINV = NINV$

Tax and Saving Rates

The other set of parameters to be calibrated determine the various tax rates and household saving rate, including :

- income tax rate $\left(t^H\right)$

- the indirect tax rate $\left(t_i^X\right)$

- fixed saving propensities (mps)

The SAM contains all the information which is necessary to calibrate the tax and savings rate. The total institutional income, savings and the various taxes are provided in the SAM. In the Kazakh CGE model the tariff rate $\left(t_i^M\right)$ and the export subsidy rate $\left(t_i^E\right)$ are zero in the base year.

The income tax rate can be calibrated from equation (20) as:

$$t^H = HHTAX/Y^H$$

Similarly from equation (23), the fixed saving propensities for households are calibrated as:

$$mps = HHSAV/Y^H\left(1-t^H\right)$$

Finally, the indirect tax rates are calculated from equation (18):

$$t_i^X = INTAX_i \Big/ \sum_i P_i^X \cdot X_i$$

where $INTAX_i$ is the total value of indirect tax paid for sector i.

Factor Income Proportionality Constants

The model is designed to reflect the factor market distortions with the sector-specific parameter, wf_{if}. The SAM provides the values of factor payments by sector for both labor and capital. The sectoral factor payment and the quantity of each factor is obtained from the Goskomstat. The average wage can be calculated by dividing the total labor payment by the total number of workers. After the economywide average wage is calculated, then it is possible to obtain the sector-specific parameter as:

$$wf_{iL} = \frac{w_i}{AFP_L}$$

where w_i is the wage rate in sector i, AFP_L is the average wage rate which is constant for all sectors, and wf_{iL} is the sector-specific parameter for labor.

Similarly, the wf_{iK} parameters for the capital market can be obtained in the same way as for labor.

Production and Trade Aggregation Functions

Once the trade elasticities are determined, the parameters of the production and trade aggregation functions can be calibrated. These parameters are as follows:

- Cobb-Douglas production function share parameter (α_{if})

- Cobb-Douglas production function shift parameter $\left(a_i^D\right)$

- CES function shift parameter $\left(a_i^C\right)$

- CES function share parameter $\left(\delta_i\right)$

- CET function shift parameter $\left(a_i^T\right)$

- CET function share parameter $\left(\gamma_i\right)$

- export demand shift parameter $\left(exp_i\right)$

The values in the SAM is defined in both nominal and real values since all the prices in the base year are assumed to be one. Thus, once the average factor prices and the sector-specific parameters for factor markets are known, Cobb-Douglas production function share parameters can easily be obtained from equation (2):

$$\alpha_{if} = \frac{AFP_f \cdot wf_{if} \cdot FD_{if}}{P_i^V \cdot X_i}$$

Then, Cobb-Douglas production function shift parameter;

$$a_i^D = X_i \Big/ \prod_f FD_{if}^{\alpha_{if}}$$

Calibration of CET and CES functions parameters require exogenous estimates of the elasticity parameters. These parameters, namely trade substitution and price elasticities of export demand are assumed as given in Table 2.2. Trade substitution elasticities determine the responsiveness of domestic demand to changes in the relative price of imported goods caused by

Table 2.2: Elasticities

Sectors	Elasticity of substitution between imports and domestic goods	Elasticity of substitution between exports and domestic goods	Price elasticity of export demand
1. Electricity	0.90	0.45	1.00
2. Fuel	0.70	0.35	1.00
3. Metallurgy	0.70	0.35	1.00
4. Manufacturing sectors	0.60	0.30	1.00
5. Agriculture	2.00	1.00	1.00
6. Construction	-	-	-
7. Productive services	-	-	-
8. Non productive services	-	-	-

any exogenous event. Since the extent of product differentiation due to differences in quality and degree of product homogeneity are not the same for each sector, sectoral substitution elasticities between foreign and home goods also vary. Thus, agricultural products have relatively high trade substitution elasticities since they are the most homogeneous products.

Given the trade substitution elasticity, $\sigma=1/(1+\varphi)$ the only unknown in equation (8) is the CES function share parameter δ_i and it can be calculates as:

$$\frac{\delta_i}{(1-\delta_i)}=\frac{P_i^D}{P_i^M}\left[\frac{M_i}{D_i}\right]^{1/\sigma_i}$$

and $\delta_i=\frac{\ni}{1+\ni}$ where $\ni=\frac{P_i^D}{P_i^M}\left[\frac{M_i}{D_i}\right]^{1/\sigma_i}$.

Substituting δ_i in to equation (7) CES function shift parameter is obtained as[4]:

$$a_i^C=Q_i/\left[\delta_i M_i^{-\varphi_i}+(1-\delta_i)D_i^{-\varphi_i}\right]^{-1/\varphi_i}$$

The CET function parameters and export demand shift parameter are computed in a similar way.

Once the calibration procedure is completed, it is possible to solve the model described in Chapter 2. The set of simultaneous non-linear equations in the model is solved using the packaged software called the General Algebraic

[4]Note that $\varphi_i=\frac{1-\sigma_i}{\sigma_i}$.

Modeling System (GAMS).[5] GAMS provides a system structure and programming language in which conciseness of expression is maintained for solving the large multisectoral economywide models consist of plenty non-linear functions.

2.4 Base Year

The eight-sector CGE model is estimated for the Kazakh economy for 1993. The availability of data and the introduction of the three-year industrial privatization program along with the new currency forced us to choose 1993 as a base year. Table 2.3 shows the sectoral characteristics of the economy in the base year. The first three columns of Table 2.3 provide the essential characteristics for each sector. Sector shares in total gross output exhibit an output distribution of semi-industrial country. Agriculture and total services provide approximately 50% of gross output. The importance of intermediate inputs for each sector is indicated by the per-unit ratio of net price to gross domestic price in column (2). Column (3) gives the capital-labor ratio in each sector. Non-productive services are the most labor intensive whereas energy sector are the most capital intensive.

Of the eight sectors, only three - construction, productive and non-productive sectors are 'pure' non-tradables. Of the remaining five, four are net

[5]See Brooke, A.; D. Kendrick and A. Meeraus [1988].

Table 2.3 :Kazakhstan- Structure of the Sectors

Sectors	(1) SX	(2) PN/PD	(3) K/L	(4) E/X	(5) RID	(6) NT
1. Electricity	5.7	37.0	12.9	9.6	9.5	33.1
2. Fuel	6.7	35.1	16.0	31.4	33.5	328.2
3. Metallurgy	9.8	26.3	5.5	39.4	24.5	1401.0
4. Manufacturing sectors	20.1	43.6	4.6	40.0	137.7	-4993.2
5. Agriculture	14.6	49.6	7.0	23.3	5.0	1651.0
6. Construction	7.6	58.8	1.6	-	-	-
7. Productive services	21.3	51.3	12.4	-	-	-
8. Non productive services	14.1	26.7	0.6	-	-	-

Notes :

SX : Sector shares in total gross output
PN/PD : Sectoral value-added as a percent of domestic price
K/L : Capital to labor ratio :(million Tenge/man-year)
E/X : Ratio of exports to domestic output (%)
RID : Ratio of imports to total domestic demand (%)
NT : Net trade (millions of tenge)

exporters (mainly energy, metallurgy and agriculture), while manufacturing sectors are net importers. Column (5) indicates that manufacturing sectors are import dependent. Even though Kazakhstan has large oil reserves, fuel industry in column (5) has high import ratio to total domestic demand. The lack of the pipeline between oil reserves and refineries may be the reason of this conflict.

Sectoral employment is given in Table 2.4. Metallurgy is a high profile employer- it accounts for approximately 15% of industrial sector. Industrial sector accounts for more than a fifth of total employment. Approximately 23% of total employment is agriculture, 9% is construction. And the remaining 46% are employed in services.

Table 2.4: Kazakhstan- Employment

(thousands of persons)

Sectors	Average number of employees
1. Electricity	85.3
2. Fuel	105.4
3. Metallurgy	183.3
4. Manufacturing sectors	821.2
5. Agriculture	1296.0
6. Construction	516.0
7. Productive services	995.0
8. Non productive services	1541.0
Total	2620.9

CHAPTER 3

This chapter reports the simulation results of the Kazakhstan CGE model discussed in Chapter 2.

In Section 1, we present four experiments. Each experiment analyzes the impacts of different exogenous shocks to the economy. In Section 2, the same experiments are repeated with higher level of elasticity estimates to compare and analyze the sensitivity of the model.

3.1 Simulation Results

In this section, we describe four simulations to explore the consequences of possible changes that the Kazakh economy may undergo during the transition period. All simulations begin from a common starting point in the base year of 1993.

In the first experiment, E-1, the multisectoral Kazakh CGE model is used to analyze the impact of an oil boom on the economy. The second experiment, E-2, introduces a 50 percent export tax on the oil sector. A 20-percent tariff is imposed on imports in experiment E-3. Finally, the last experiment, E-4, considers the effects of a decrease in labor force on the economy.

Experiment E-1: Impact of higher oil revenues

In a World Bank study, it is argued that the oil potential of Kazakhstan may constrain the development of the other sectors and the appreciation of the real exchange rate may make the other sectors less competitive.[1] This phenomena, known as the "Dutch-disease" in the literature, may bring about a sluggish growth in the non-resource sectors. In this experiment, it is assumed that the main impact of the oil sector will consist of higher foreign earnings. Therefore, in the first experiment $700 millions of foreign earnings are injected into the economy to analyze the effects of an oil boom. In the model, earnings from exports are channeled directly to investment. Thus, it is assumed that oil earnings are entirely used for investment. Table 3.1 summarizes the macroeconomic impact of the higher oil revenues. Real fixed investment increases by 67 percent; domestic prices rise at an average rate of 50 percent, and nominal wages go up by approximately 54 percent.

Table 3.2 presents the sectoral results. The rise in the prices of domestic goods are shown in the first column. High profile trading sectors such as metallurgy and energy show the smallest price increases. The second column shows the changes in the structure of production. Production declines in all traded sectors. Metallurgy, as a net exporter sector, shows the largest

[1] "Kazakhstan: The Transition to a Market Economy", *A World Bank Country Study*, 1993.

Table 3.1: Macroeconomic Implications of Higher Oil Revenues

	(Percentage change from base)
GDP deflator	56.6
Domestic prices	50.1
Composite prices	41.5
Nominal wages	53.9
Foreign savings	279.6
Household savings	53.3
Government savings	55.2
Depreciation	39.2
Total savings	92.3
Fixed investment	126.1
Real investment	66.9
Indirect taxes	43.7
Total revenue	50.4

Table 3.2: Sectoral Implications of Higher Oil Revenues

	PD	X	E	M	LF
1. Electricity	38.6	-5.5	-12.6	27.7	-19.2
2. Fuel	46.8	-9.3	-14.4	21.3	-25.0
3. Metallurgy	31.9	-17.1	-18.4	1.6	-36.8
4. Manufacturing sectors	67.1	-2.9	-10.4	37.6	-8.3
5. Agriculture	55.0	-0.8	-18.1	149.7	-1.6
6. Construction	52.7	6.3	-	-	12.7
7. Productive services	53.7	5.0	-	-	13.4
8. Non productive services	55.2	0.0	-	-	0.0
Total	50.1	-1.8	-14.1	36.7	0.0

Notes:
PD: Domestic prices
X: Domestic output
E: Exports
M: Imports
LF: Labor force

contraction followed by the energy sector. Production grows most significantly in construction which is a non-traded investment good.

Turning to the impact of oil revenues on foreign trade, the investment boom causes total exports to fall by 14.1 percent and total imports to grow by 36.7 percent. This is not surprising given the real appreciation of currency. However, imports in metallurgy increase only by 1.6 percent, probably because of the low substitutability in both domestic and export trade markets. Note that agriculture shows the largest increase in imports, indicating a higher degree of import dependency in this sector.

The effect of oil revenues on the labor market turns out to be as expected. The labor force in traded sectors decreases whereas it increases in non-traded sectors. The results are consistent with the output changes. The largest decrease in employment is seen in the energy and metallurgy sectors. The movement of labor across sectors is the result of the change in domestic prices. Since labor is assumed to be fully employed, the total change in employment is zero.

Experiment E-2: Impact of a 50 percent tax on the oil sector's exports

Exports are the best way to rapid growth for Kazkhstan during the transition period. Policy instruments such as taxes and licenses would negatively affect the economy by restricting exports. However, in certain sectors, particularly oil, export restrictions are necessary to keep the domestic prices below the world prices. Export taxes are to be preferred in place of quantitative restrictions or licensing.[2]

There are no explicit export taxes in the base year SAM. In this section we examine the effects of a 50 percent export tax on the oil(fuel) sector. Table 3.3 describes the macroeconomic impact of the export taxes on the fuel sector products. Total revenue increases by 5 percent and nominal wages decrease by 2.3 percent.

Table 3.4 details the sectoral implications of the imposition of taxes on fuel exports. The world prices of exports in the fuel industry increase by approximately 25 percent. Production in this sector is negatively affected by the export tax as expected. Production decreases in the energy sectors (fuel and electricity) by a total of 9 percent. A similar impact of the export taxes is also observed in the exports of the energy sectors, which decline approximately by 20 percent. In imports different effects are observed. In general, restrictions on exports bring about a significant implicit tax on imports. However, the imports of the fuel industry increased slightly (by 1 percent) rather than decreasing. The electricity imports declined by

[2]For further discussion of the comparison of export taxes and export licenses, see "Kazakhstan: The Transition to a Market Economy", *A World Bank Country Study*, 1993, pp.171.

Table 3.3: Macroeconomic Implications of Tax Introduction into Oil Exports

	(Percentage change from base)
GDP deflator	0.1
Domestic prices	-0.2
Composite prices	-0.3
Nominal wages	-2.3
Household savings	-2.8
Government savings	11.1
Depreciation	-0.7
Total savings	4.2
Fixed investment	6.5
Real investment	7.1
Indirect taxes	-2.7
Total revenue	5.1

Table 3.4: Sectoral implications of Tax Introduction into Oil Exports

(Percentage change from base)

	PWE	X	E	M	LF
1. Electricity	0.5	-1.5	-0.5	-3.3	-5.6
2. Fuel	24.7	-7.6	-19.8	1.2	-20.6
3. Metallurgy	-0.5	0.5	0.5	0.0	1.3
4. Manufacturing sectors	-0.6	0.6	0.6	0.0	1.7
5. Agriculture	-0.6	0.4	0.6	-1.5	0.7
6. Construction	-	0.4	-	-	0.8
7. Productive services	-	-0.1	-	-	-0.4
8. Non productive services	-	0.0	-	-	0.0
Total	2.9	-0.4	-1.8	0.0	0.0

Notes:
PWE: World price of exports
X: Domestic output
E: Exports
M: Imports
LF: Labor force

approximately 3 percent. Employment decreased in the energy sectors by 20.3 percent, due to the decline of production in these sectors.

Experiment E-3: Impact of a 20 percent tariff

During the transition period, free trade would create significant fluctuations in the economy. Import taxes should be used as an effective transitional tool to provide a limited protection for the economy. High tariff rates would be disadvantageous because they will hurt exports and industries with positive value-added.[3] Tariff rates should be kept low.

There are no explicit tariffs in the base year SAM. In January 1995 the government introduced new tariffs on imports. These import controls were necessary for both revenue and protection purposes. In this section we examine the effects of a 20 percent tariff rate on all sectors. Table 3.5 depicts the macroeconomic implications of a 20 percent tariff. Total revenue increases by 42.1 percent, real fixed investment goes up by approximately 23.8 percent, domestic prices rise at an average rate of 15.9, percent and nominal wages are raised by 11.2 percent.

Turning to Table 3.6, which summarizes the sectoral implications of a 20 percent tariff on imports, we observe that domestic prices increase not only

---

[3]For further discussion of the negative impacts of high tariff rates, see "Kazakhstan: The Transition to a Market Economy", *A World Bank Country Study*, 1993, pp.174.

Table 3.5: Macroeconomic Implications of a 20 percent Tariff on Imports

	(Percentage change from base)
GDP deflator	20.3
Domestic prices	15.9
Composite prices	16.2
Nominal wages	11.2
Household savings	10.5
Government savings	70.9
Depreciation	17.8
Total savings	36.3
Fixed investment	46.5
Real investment	23.8
Total revenue	42.1

Table 3.6: Sectoral Implications of a 20 percent Tariff on Imports

(Percentage change from base)

	PD	X	E	M	LF
1. Electricity	14.6	-1.0	-4.5	-4.7	-3.6
2. Fuel	16.3	-1.7	-4.3	-2.7	-4.9
3. Metallurgy	18.4	-4.6	-6.6	-4.2	-10.8
4. Manufacturing sectors	19.9	-0.7	-3.4	0.9	-2.0
5. Agriculture	16.0	-0.3	-6.5	-5.2	-0.6
6. Construction	15.9	2.8	-	-	5.7
7. Productive services	15.0	0.9	-	-	2.4
8. Non productive services	11.4	0.0	-	-	0.0
Total	15.9	-0.4	-4.8	0.0	0.0

Notes:
PD: Domestic prices
X: Domestic output
E: Exports
M: Imports
LF: Labor force

in trading sectors but in non-trading sectors as well. The highest increase is seen in trading sectors. The manufacturing sector has the highest increase in domestic prices by approximately 19.9. The Manufacturing sector has also the highest ratio of imports to total domestic demand, and this is reflected by its having the highest rate of increase in its domestic prices. Domestic output exhibits a negligible decrease in tradable goods, except metallurgy which decreases by 4.6 percent.

The effect of tariffs on foreign trade is as expected. The volume of trade decreases in almost all sectors. Exports decline in all sectors, and the major reason for this is that exporters pay for the tariffs imposed on their imported intermediate inputs. This is seen most explicitly in metallurgy which offers the highest rate of decline of 6.6 percent, because its 0.70 ratio of the imported intermediate goods usage is the highest among others. Imports decline in all sectors except manufacturing, which is highly import-dependent.

Experiment E-4: Impact of a decline in labor supply

After the breakdown of the Soviet Union, the population of the former Soviet Republics is falling largely as employees are emigrating due to a falling standard of living. Most of the former Soviet Republics are experiencing a damaging loss of human capital. One can argue that emigration of the work force to seek better standards of living elsewhere can resolve the overmanning problem which was created by the socialist ideology of the right to employment. Kazakhstan is one of the former Soviet Republics that has been suffering with overmanning for a long time. However, during 1994 and 1995, Kazakhstan experienced a reduction in its labor force by roughly 14 percent.[4] One can expect that this reduction will cause severe problems for the Kazakh economy. On the other hand, this would be a solution for the country's long time overmanning problem.

In this section, I analyze the response of the Kazakh economy to a decline in its labor force is analyzed through decreasing the total labor force by 20 percent; a higher decrease than the one observed in 1994 and 1995. Table 3.7 presents the macroeconomic effects of a decrease in the labor force. The decrease in the labor supply caused nominal wages to increase by 46 percent and real wages by 15 percent. Domestic prices also rise by 24 percent due to the increase in the labor cost.

To understand how the structure of the economy is affected by a shift in labor supply, one must analyze the effects sector by sector. Table 3.8 summarizes the sectoral results. As it is shown in the first column of Table 3.8, the energy and metallurgy sectors show the lowest price increase (electricity by 13 percent, fuel by 18 percent, and metallurgy by 13 percent).

[4] "Kazakhstan Economic Trends", DIW German Institute for Economic Research, 1996

Table 3.7: Macroeconomic Implications of a Decline in Labor Supply

	(Percentage change from base)
GDP deflator	27.5
Domestic prices	24.2
Composite prices	21.3
Nominal wages	46.7
Household savings	13.2
Government savings	-14.3
Depreciation	16.4
Total savings	-0.6
Fixed investment	-0.3
Real investment	-12.7
Indirect taxes	5.5
Total revenue	10.9

Table 3.8: Sectoral Implications of a Decline in Labor Supply

(Percentage change from base)

	PD	X	E	M	LF
1. Electricity	13.2	-11.8	-11.8	-1.4	-37.9
2. Fuel	18.8	-12.6	-13.2	-1.1	-32.7
3. Metallurgy	13.2	-15.7	-15.0	-8.5	-34.1
4. Manufacturing sectors	21.9	-12.1	-13.0	-0.4	-31.3
5. Agriculture	25.6	-13.8	-16.7	37.5	-26.3
6. Construction	26.2	-12.7	-	-	-23.3
7. Productive services	22.1	-10.7	-	-	-25.3
8. Non productive services	53.0	0.0	-	-	0.0
Total	24.2	-10.7	-14.1	0.0	-19.8

Notes:
PD: Domestic prices
X: Domestic output
E: Exports
M: Imports
LF: Labor force

Output decline is observed in all sectors except the non-production sector. The largest decline is seen in metallurgy by 15 percent.

The impact of a decline in labor force is similar in all. Total exports fall by 12 percent because the increase in prices causes Kazakhstan to lose its competitiveness in the international markets. Sectoral imports show surprising results. Overall imports decreased by 5 percent. Agriculture appears to be the only sector with an increase in imports by 37 percent. This may be explained by a relatively large production loss in that sector.

Finally, and not surprisingly, another outcome of the 20 percent decrease in the labor supply is an overall decline in employment.[5]

3.2 Sensitivity Analysis

One of the major assumptions of the model is imperfect substitutability among foreign and domestic traded goods. As local prices and wages rise during the investment boom, elasticities determine the rate at which imports can replace domestic production. Therefore, the sensitivity of the model to the elasticities are important and should be examined to understand the behavior of the economy.

The experiments presented in this paper use relatively low elasticities for substitution between home and foreign goods. As a comparison, the base

[5]Note that labor supply in non-productive services is assumed constant.

experiments are repeated changing only the elasticities of home/foreign good substitution for the energy and metallurgy sectors. In each case, the elasticity is raised to the maximum possible level.

In the first experiment, the "high elasticity" creates the similar amount of new investment as the base foreign experiment, but it gives way to a different kind of boom. Table 3.9 shows the results of the first experiment under the assumption of low and high elasticities. The pattern of price increases is similar to that of the base (low elasticity) experiment but the magnitude is smaller (35 percent versus 50 percent). High elasticity implies a greater competition from foreign goods imported at constant world prices. Those sectors whose substitution elasticity has been raised show smaller price increases. Due to the higher competition the prices increase less than they would have done in a situation of low competition. Output changes in the "high elasticity" experiment show similar results as in the base case, but instead of contraction of agriculture, expansion is observed.

Event though total change in imports is the same in both cases, the patterns are different. The patterns of change in imports show how easily foreign goods replace domestic goods in these sectors.

The reallocation of labor among the sectors reflects the pattern of output changes, and wages rise only 45 percent as compared to 54 percent in the first experiment.

Table 3.9: Model results under assumption of low and high elasticities of substitution between home and foreign goods: Experiment 1

(percentage change from base year)

Sector	Low elasticity	High elasticity
Domestic prices		
1. Electricity	38.6	17.7
2. Fuel	46.8	16.9
3. Metallurgy	31.9	8.6
4. Manufacturing sectors	67.1	57.2
5. Agriculture	55.0	46.6
6. Construction	52.7	43.9
7. Productive services	53.7	44.1
8. Non productive services	55.2	47.8
Total	50.1	35.4
Output		
1. Electricity	-5.5	-11.1
2. Fuel	-9.3	-18.4
3. Metallurgy	-17.1	-19.9
4. Manufacturing sectors	-2.9	-1.9
5. Agriculture	-0.8	0.5
6. Construction	6.3	5.4
7. Productive services	5.0	4.9
8. Non productive services	0.0	0.0
Total	-1.8	-2.7

<u>Table 3.9 (continued)</u>

Sector	Low elasticity		High elasticity
Imports			
1. Electricity	27.7		70.8
2. Fuel	21.3		51.7
3. Metallurgy	1.6		9.6
4. Manufacturing sectors	37.6		33.7
5. Agriculture	149.7		125.3
6. Construction	-	-	-
7. Productive services	-	-	-
8. Non productive services	-	-	-
Total	36.7		36.7
Exports			
1. Electricity	-12.6		-12.3
2. Fuel	-14.4		-17.7
3. Metallurgy	-18.4		-18.0
4. Manufacturing sectors	-10.4		-8.6
5. Agriculture	-18.1		-15.5
6. Construction	-	-	-
7. Productive services	-	-	-
8. Non productive services	-	-	-
Total	-14.1		-13.1
Labor			
1. Electricity	-19.2		-36.0
2. Fuel	-25.0		-45.0
3. Metallurgy	-36.8		-41.8
4. Manufacturing sectors	-8.3		-5.3
5. Agriculture	-1.6		0.9
6. Construction	12.7		10.9
7. Productive services	13.4		13.1
8. Non productive services	0.0		0.0
Total	0.0		0.0

Thus the elasticity of substitution between foreign and domestic goods exerts a crucial impact on the characteristics of an investment boom produced by a $700 millions of foreign earnings. It affects domestic price and wage increases, and thereby the appreciation of the real exchange rate, the structure of output changes, and the magnitude of trade changes.

Similar results are obtained in the high elasticity runs of the other experiments. Table 3.10 compares the model results under the assumption of low and high elasticities for the experiments E-2, E-3 and E-4. Trade elasticities are important particularly in the third experiment in which tariffs are imposed on imports. For those sectors in which the elasticities are increased, the impact of the tariffs on domestic prices are much higher. Electricity prices increased by 16.53 percent with higher elasticity as against 14.60 percent in the case of low elasticity. A similar effect is also observed in fuel and metallurgy.

Table 3.10: Model results under assumption of low and high elasticities of substitution between home and foreign goods: Experiments 2,3,4

(percentage change from base year)

	E-2		E-3		E-4	
Sector	Low	High	Low	High	Low	High
Domestic prices						
1. Electricity	-1.9	-2.5	14.6	16.5	13.2	6.1
2. Fuel	6.6	3.5	16.3	18.5	18.8	7.4
3. Metallurgy	-0.6	-0.4	18.4	19.6	13.2	3.9
4. Manufacturing sectors	-0.9	-1.5	19.9	20.8	21.9	18.1
5. Agriculture	-0.9	-1.5	16.0	16.7	25.6	22.2
6. Construction	-1.0	-1.6	15.9	16.6	26.2	22.7
7. Productive services	-1.1	-1.8	15.0	15.8	22.1	18.4
8. Non productive services	-1.8	-2.3	11.4	12.0	53.0	49.3
Total	-0.2	-1.0	15.9	17.1	24.2	18.5
Output						
1. Electricity	-1.5	-1.2	-1.0	-0.3	-11.8	-13.5
2. Fuel	-7.6	-9.7	-1.7	-1.1	-12.6	-16.0
3. Metallurgy	0.5	1.2	-4.6	-4.6	-15.7	-16.7
4. Manufacturing sectors	0.6	0.7	-0.7	-0.8	-12.1	-11.6
5. Agriculture	0.4	0.5	-0.3	-0.4	-13.8	-13.3
6. Construction	0.4	0.3	2.8	2.9	-12.7	-13.0
7. Productive services	-0.1	-0.2	0.9	0.9	-10.7	-10.8
8. Non productive services	0.0	0.0	0.0	0.0	0.0	0.0
Total	-0.4	-0.4	-0.4	-0.3	-10.7	-11.0

Table 3.10 (continued)

Sector	E-2 Low	E-2 High	E-3 Low	E-3 High	E-4 Low	E-4 High
Imports						
1. Electricity	-3.3	-10.7	-4.7	-10.9	-1.4	9.4
2. Fuel	1.2	8.2	-2.7	-4.6	-1.1	10.7
3. Metallurgy	0.0	-0.5	-4.2	-4.5	-8.5	-4.6
4. Manufacturing sectors	0.0	-0.3	0.9	1.3	-0.4	-1.9
5. Agriculture	-1.5	-2.7	-5.2	-4.0	37.5	30.5
6. Construction	0.0	0.0	0.0	0.0	0.0	0.0
7. Productive services	0.0	0.0	0.0	0.0	0.0	0.0
8. Non productive services	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0	0.0	0.0	0.0	0.0
Exports						
1. Electricity	-0.5	-0.2	-4.5	-4.5	-11.8	-11.3
2. Fuel	-19.8	-20.7	-4.3	-4.1	-13.2	-14.3
3. Metallurgy	0.5	1.0	-6.6	-6.9	-15.0	-14.7
4. Manufacturing sectors	0.6	0.8	-3.4	-3.6	-13.0	-12.2
5. Agriculture	0.6	0.9	-6.5	-6.8	-16.7	-15.5
6. Construction	0.0	0.0	0.0	0.0	0.0	0.0
7. Productive services	0.0	0.0	0.0	0.0	0.0	0.0
8. Non productive services	0.0	0.0	0.0	0.0	0.0	0.0
Total	-1.8	-1.7	-4.8	-5.0	-14.1	-13.6
Labor						
1. Electricity	-5.6	-4.6	-3.6	-1.0	-37.9	-42.3
2. Fuel	-20.6	-25.8	-4.9	-3.1	-32.7	-40.0
3. Metallurgy	1.3	2.9	-10.8	-11.0	-34.1	-36.1
4. Manufacturing sectors	1.7	2.0	-2.0	-2.4	-31.3	-30.2
5. Agriculture	0.7	1.0	-0.6	-0.8	-26.3	-25.5
6. Construction	0.8	0.6	5.7	5.9	-23.3	-23.9
7. Productive services	-0.4	-0.6	2.4	2.5	-25.3	-25.5
8. Non productive services	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0	0.0	0.0	-19.8	-19.8

CONCLUDING REMARKS

In this dissertation, I developed a multisectoral computable general equilibrium (CGE) model for the Kazakh economy. It should be noted that the Kazakh CGE model does not analyze the macroeconomic monetary mechanisms. It does not attempt to capture the short-term mechanisms either. It rather describes a medium-term adjustment process.

The simulations of the Kazakh CGE model have yielded important results. First, an oil boom will exert different effects on each sector. The tradable sectors, mostly metallurgy and energy, will face output contraction. Clearly, some form of subsidy to the harmed sectors will be appropriate. Unless the government pays more attention to developing the competitiveness of the non-oil sectors, Kazakhstan's mineral and energy wealth may constrain the development those sectors. Second, the levying of an export tax on oil will cause a decline in both the production and the exports of this industry. Third, the imposition of tariffs on imports are necessary for both revenue and protection purposes. Finally, immigration during the transition period will reduce the labor force, which in turn will negatively effect the country's economy.

The major contribution of this dissertation is the depiction of the potential problems during the transition period in Kazakhstan. One final observation is that further research on the subject is required. In particular, future research should address the following two issues.

In the first place, as data become more available, different levels of aggregation of the economy in terms of both sectors and labor skills should be included in to the CGE framework. This would allow the policy makers to analyze the effects of exogenous shocks on each classified sector and skill class of labor force.

In addition, future research should address the issue of government policy which promotes the competition in the non-oil sector through the implementation of a liberal trade regime, such as removing all internal barriers to competition and lifting the controls on the domestic market arrangements. Increased flexibility in both the goods and labor markets should allow the non-oil sector to respond successfully to increased domestic market competition.

APPENDIX A: SECTORAL CLASSIFICATION

Table A1 : Sectoral Classification Scheme Used in National Accounts

1. Power

2. Fuel (including oil, gas and coal)

3. Ferrous Metallurgy

4. Nonferrous Metallurgy

5. Chemical and Petroleum

6. Machinery and Metal works

7. Sawmill and Lumber industry

8. Building materials

9. Glass and Ceramic industry

10. Light industry

11. Food industry

12. Microbiology

13. Branch of food industry

14. Printing

15. Other industries

16. Agriculture

17. Fishing

18. Forestry

19. Construction

Table A1: (continued)

20. Transportation

21. Communications

22. Wholesale trade

23. Retail trade and catering

24. Material supply

25. Procurement

26. Information and computing services

27. Geology

28. Other branches of material production

29. Housing

30. Healthcare

31. Physical culture and sports

32. Social security

33. Education

34. Culture and art

35. Science and scientific services

36. Credit and insurance

37. General administration and defense

38. Private non-profit institutions serving households

Table A2 : Sectoral Classification Scheme Used in Input-Output Table

1. Electricity
2. Fuel (including oil and gas, coal, other fuel)
3. Ferrous Metallurgy
4. Non-ferrous Metallurgy
5. Chemical and Petroleum
6. Machinery and metal works
7. Sawmill and lumber industry
8. Building materials (including glass and ceramic)
9. Light industry
10. Food industry
11. Other Sectors of Ind.
12. Construction
13. Farming and Forestry (including agriculture)
14. Transport (Cargo)
15. Communications (in the service sphere of production industry)
16. Trade and Public catering (including procurement and logistics)
17. Other types of activities in the sphere of material production

Table A3: Sectoral Classification Used in the Kazakh CGE Model

1. Electricity

2. Fuel

3. Ferrous and Non-ferrous metallurgy

4. Manufacturing sectors (Chemical and petroleum, machinery and metal works, sawmill and lumber, building materials, glass and ceramic industry, textiles, food, microbiology, printing).

5. Agriculture

6. Construction

7. Productive services (Transportation, communications, wholesale trade, retail trade and catering, material supply, procurement, information and computing services, geology).

8. Non-productive services (Housing, healthcare, physical culture and sports, social security, education, culture and art, science and scientific services, credit and insurance, general administration and defense, private non-profit institutions serving households).

Table A4: Foreign Trade Main Commodities

1. Live animals & animal products

2. Vegetable products

3. Animal or vegetable fats and oil and their cleavage products; prepared edible fats; animal or vegetable waxes

4. Prepared foodstuffs, beverages, spirits and vinegar; tobacco and manufactured tobacco substitutes

5. Mineral products

6. Products of the chemical and allied industries

7. Plastics and articles thereof; rubber and articles thereof

8. Raw skins, leather, furskins and articles thereof; saddlery and harness; travel goods, handbags and similar containers; articles of animal gub

9. Wood and articles of wood; wood charcoal; cork and articles of cork; manufactures of straw, of esparto or of other plating materials; basketware and wickerwork

10. Pulp of wood or of other fibrous cellulose material; waste and scrap of paper of paperboard; paper and paperboard and articles thereof

11. Textiles and textile articles

Table A4: (continued)

12. Footwear, headwear, umbrellas, walking sticks, seat-sticks, whips, riding crops and parts thereof; prepared feathers and articles made the rewith; artificial flowers; articles human hair

13. Articles of stone, plaster, cement, asbestos, mica or similar materials, ceramic products; glass and glassware

14. Natural or cultured pearls, precious or semiprecious stones, base metals, cover oneself and clad with precious metal and articles thereof, imitation jewelry; coin

15. Base metals and articles of base metal

16. Machines and mechanical appliances; electrical equipment; parts thereof; sound recorders and reproducers, and parts and accessories of such articles

17. Vehicles, aircraft, vessels and associated transport equipment

18. Optical, photographic, cinematographic, measuring, checking, precision, medical of surgical instruments and apparatus; clocks and watches: musical instruments ;parts and accessories thereof

19. Miscellaneous manufactured articles

20. Works of art, collectors pieces, and antiques

APPENDIX B: NATIONAL ACCOUNTS FOR KAZAKHSTAN, 1993

Table B1: Goods and Services Account, 1993

Resources	
Output of goods and services	57127.3
Imports of goods and services	12049.9
Net taxes on products	2146.6
Net taxes on imports	0.0
Total	71323.8
Uses	
Intermediate consumption	32435.6
Final consumption	19540.2
Gross *fixed* capital formation	8878.0
Exports of goods and services	10470.0
Total	71323.8

Source: State Statistical Committee (Goskomstat).

Table B2: Production Account, 1993

Resources	
Output of goods and services	57127.3
Net taxes on products	2146.6
Net taxes on imports	0.0
Total	59273.9
Uses	
Intermediate consumption	32435.6
GDP at mrk prices	26838.3
Total	59273.9

Source: State Statistical Committee (Goskomstat).

Table B3: Generation of Income Account, 1993

Resources	
GDP at market prices	26838.3
Production and import subsidies	593.2
Total	27431.5
Uses	
Compensation of employees	11046.3
Taxes on production and imports	3239.7
of which	
on products	2146.6
on production	1093.1
Subsidies on production and imports	
Gross operating surplus of the economy	13145.5
Consumption of fixed capital	1566.5
Net operating surplus of the economy	11579.0
Total	27431.5

Source: State Statistical Committee (Goskomstat).

Table B4: Use of Income Account, 1993

Resources	
Gross national disposable income	26731.4
Total	26731.4
Uses	
Final national consumption expenditure	19540.2
households	15950.0
general government	3464.6
private nonprofit institutes serving household	125.6
Gross national saving	7191.2
Total	26731.4

Source: State Statistical Committee (Goskomstat).

Table B5: Capital Account, 1993

Resources	
Gross national saving	7191.2
Capital transfers from the rest of the world	1088.0
Total	8279.2
Uses	
Gross fixed capital formation	7518.0
Change in stocks	2926.5
Net purchases of land and intangible assets	0.0
Net lending(+)or net borrowing(-) of the nation	-1806.9
Capital transfers to the rest of the world	2774.6
Total	11412.2

Source: State Statistical Committee (Goskomstat).

BIBLIOGRAPHY

Adelman, I., and S. Robinson [1978], *Income distribution Policies in Developing Countries*, Stanford, Calif.: Stanford University Press.

Ahluwalia, M., and F. Lysy [1979], "Welfare Effects of Demand Management Policies: Impact Multipliers Under Alternative Model Structures," *Journal of Policy Modeling*, vol. 1 , no. 3, pp. 317-43.

Benjamin, N. C.; S. Devarajan and R. J. Weiner [1989], "The 'Dutch Disease' in a Developing County: Oil Reserves in Cameroon." *Journal of Development Economics*, Vol. 30, pp. 71-92.

Bergman, L.; [1990], "The Development of Computable General Equilibrium Modelling" pp.3-32 in Bergman, L.; D.W. Jorgenson and E. Zalai, eds., *General Equilibrium Modelling and Economic Policy Analysis*, New York: Oxford University Press.

Brooke, A.; D. Kendrick and A. Meeraus [1988], *GAMS: A User's Guide*, Redwood City. Ca.: The Scientific Press.

Chenery, H.; J. Lewis; J. de Melo and S. Robinson [1986], "Alternative Routes to Development" pp.311-347 in H. Chenery; S. Robinson and M. Syrquin, eds., *Industrialization and Growth: A Comparative Study*, New York: Oxford University Press.

Chiang, A.C.[1984], *Fundamental Methods of Mathematical Economics*, New York: McGraw-Hill, Inc.

Dervis, K. [1980], "Analyzing the Resource Pull Effect of a Devaluation Under Exchange Control", *Journal of Development Economics*, Vol. 7, pp. 233-47.

Dervis, K. , J. de Melo and S. Robinson [1982], *General Equilibrium Models for Development Policy*, New York: Cambridge University Press.

Dewarjayan, S.; J.K. Lewis and S. Robinson [1986], "A Bibliography of Computable General Equilibrium (CGE) Models Applied to Developing Countries", Berkeley, CA: Division of Agriculture and Natural Resources, University of California, Berkeley, Working Paper No. 400.

Dewatripont, M. and M. Gilles [1987], "On Closure Rules, Homogeneity and Dynamics in Applied General Equilibrium Models", *Journal of Development Economics*, Vol. 26, pp. 65-76.

Dixon, P. B.; B. R. Parmenter; A. A. Powell and P. J. Wilcoxen [1992], *Notes and Problems in Applied General Equilibrium Economics*, Amsterdam: North Holland.

Ginsburgh, V. and J. Waelbroeck [1981], *Activity Analysis and Geeneral Equilibrium Modelling*, Amsterdam: North Holland.

Harberger, A.C. [1962], "The Incidence of the Corporation Tax", *Journal of Polictical Economy*, 70:215-40.
[1966], "Efficiency Effecs of Taxes on Income from Capital", In Krzyzaniak, M., ed., *Effects of Corporation Income Tax*, Detroit: Wayne State University Press.

Johansen,L. [1960], *A Multi-Sectoral Study of Economic Growth*, Amsterdam: North Holland.

Kennett, D.; M. Lieberman [1992], *The Road to Capitalism: Economic Transformation in Eastern Europe and the Former Soviet Union*, Texas: Dryden Press.

Leontief, W.W.[1951], *The Structure of American Economy, 1919-1939*, 2d ed., Oxford University Press, N.J:Fair Lawn.

Lysy, F., and L. Taylor [1980], "A computable General Equilibrium Model for the Functional Distribution of Income: Experiments for Brazil, 1959-71," in Taylor et al., *Models of Growth and Distribution for Brazil*.

Melo, J. de and R. Sherman [1989], "Product Differentiation and the Treatment of Foreign Trade in Computable General Equilibrium Models of Small Economies." *Journal of International Economics*, Vol. 27, Nos. 1-2 (August), pp.47-67.

Organisation for Economic Co-operation and Development [1993], *National Accounts for the Former Soviet Union*, Paris: OECD.

Piggott, J. and J. Whalley [1985], *New Developments in Applied General Equilibrium Analysis*, Cambridge University Press, Cambridge.

Robinson S. [1989], "Multisectoral Models" pp.885-947 in H.B. Chenery and T.N. Srinivasan, eds., *Handbook of Development Economics*, Amsterdam: North Holland.

Robinson, S. and Tyson, L.D.[1985], "Foreign Trade, Resource Allocation, and Structural Adjustment in Yugoslavia: 1976-1980", *Journal of Comparative Economics*, vol. 9, pp. 46-70.

Scarf, H.E., and T. Hansen [1973], *The Computation of Economic Equilibria*, New Haven, Conn.: Yale University Press.

Scarf, H.E. and J.B. Shoven [1984], *Applied General Equilibrium Analysis*, Cambridge University Press, New York.

Shoven, B. John and John Whalley [1992], *Applying General Equilibrium*, Cambridge University Press, New York.
[1972], A General Equilibrium Calculation of the Effects of Differential Taxation of Income from Capital in the U.S. , *Journal of Public Economics*, Vol.1, pp.281-321.

World Bank[1994], *Statistical Handbook 1994: States of the Former USSR*, Washington, D.C. : The World Bank.
[1993], *Kazakhstan: The Transition to a Market Economy*, Washington,D.C.: The World Bank.
[1983], *Yugoslavia: Adjustment Policies and Development Perspectives*, Washington, D.C. : The World Bank

Zenios, s. A., A. Drud, and J. M. Mulvey [1986], "Balancing Some Large Social Accounting Matrices with Nonlinear Network Programming", Technical Report, Department of Civil Engineering, Princeton University, Princeton.