Economic Impact of External Income Through Labor Mobility on Economic Well-being in North Cyprus – CGE Model Approach

Nuru Giritli

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Approval of the Institute of Graduate Studies and Research

_____
Prof. Dr. Elvan Yılmaz
Director

I certify that this thesis satisfies the requirements as a thesis for the degree of Doctor of Philosophy in Economics.

_____
Prof. Dr. Mehmet Balcılar
Chair, Department of Economics

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Doctor of Philosophy in Economics.

_____
Assoc. Prof. Dr. Sevin Uğural
Supervisor

Examining Committee

_____

1. Prof. Dr. Glenn Jenkins _____
2. Prof. Dr. Işıl Akgül _____
3. Prof. Dr. Mehmet Balcılar _____
4. Prof. Dr. Ümit Şenesen _____
5. Assoc. Prof. Dr. Sevin Uğural _____

ABSTRACT

The objective of this thesis is twofold; first, to construct the first Computerized General Equilibrium (CGE) Model for the North Cyprus economy second, using the CGE model to explore the impact of external factor income in terms of remittances resulted from migration on the economic well-being in North Cyprus. The general equilibrium model is the first comprehensive model describing the economic activities in North Cyprus, and it is constructed as follows: Production process follows a 3-level nested CES function at the primary production level and Leontief structure at the intermediate level. Households demand commodities and services given that their utility is maximized; firms' investment demand is determined endogenously through a Cobb-Douglas function, government sector spends the fixed proportion of their revenues on commodities, and the external trade is determined by the Constant Elasticity of Substitution (CES) import demand function with Armington assumption and Constant Elasticity of Transformation (CET) export supply function.

Keywords: General Equilibrium Model, Factor Income from Abroad, Remittances, Labor Mobility, North Cyprus Economy

ÖZ

Bu çalışmanın amacı Kuzey Kıbrıs ekonomisine özgü özellikleri yansıtan bir genel denge (CGE) modeli oluşturmak ve genel denge modelini kullanarak göç etkisi ile birlikte göçten kaynaklanan dış dünya faktör gelirlerinin ekonomik refah üzerindeki etkilerini ayrı ayrı ölçmektir. 2-mal, 4-faktör, 13-sektör'lü bu genel denge modeli politika analizi için bir araç olarak kullanılmak üzere tasarlanmıştır. Kuzey Kıbrıs'taki mevcut üretim yapısı 3-aşamalı iç içe CES fonksiyonu kullanılarak inşa edilmiştir. Hane halkı tüketim fonksiyonu ile yatırım talebi optimizasyon koşulları çerçevesinde içsel belirlenmekle beraber, kamu sektörü harcamaları, kamu gelirlerinin sabit oranını harcayarak belirlenmiştir. Son olarak, ticaret dengesini olusturan ithalat talebi için Armington ve mal ve hizmet ihracat arzı için CET fonksiyonları kullanılmaktadır.

Anahtar Kelimeler: Genel Denge Modeli, Dış Dünya Faktör Gelirleri, Mobil Emek, Kuzey Kıbrıs Ekonomisi

To my family

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LIST OF SYMBOLS

C_i : Consumption demand of commodities

I_i : Final demand of investment expenditures

$INVENT_i$: Inventories by sector

DI : Gross fixed capital formation

INV : Total inventories

CG_i : Public consumption expenditures

EG : Total government expenditures

IM_i : Imports

E_i : Exports

K_i : Demand for capital

L_i : Demand for unskilled labor

H_i : Demand for skilled labor

R_i : Demand for productive land resource

J_i : Composite value of capital-and-unskilled labor

G_i : Composite value of capital-and-unskilled labor and skilled labor

XD_i : Domestic Output

LS : Unskilled labor supply

HS : Skilled labor supply

KS : Capital Stock

$\overline{RS}$: Supply of land and resources (exogenously fixed)

VA_i : Value Added

SX_i : Domestic sales of composite traded commodities and services

XDD_i : Domestic output supplied on the domestic market

U : Household's utility

PDD_i : Prices of domestic commodities supplied in domestic market

PIM_i : Prices of imported commodities

j_i : Composite prices of input J

g_i : Composite price of input G

PC_i : Price for commodities

P_i : Prices of domestic output

k_i : Price of capital

l_i : Wage of unskilled labor

h_i : Wage of skilled labor

r_i : Rent

$PCINDEX$: Price index

PE_i : Prices for exported commodities

PX_i : Prices of composite commodities

PMW_i : World price of imports

PEW_i : World price of exports

$TAXR$: Sum of direct and indirect taxes

$Transf$: Government transfer payments

$REMIT$: Remittances

$TRMZ$: Tax revenue on commodities

M : Household's budget

MY : Factor's income

S : Total savings

SH : Household's savings

SG : Public savings

SF : Foreign savings

tim_i : Tax rate on imports

tm_i : Tax rate on income (direct)

tk_i : Tax rate on capital

tl_i : Tax rate on unskilled labor

th_i : Tax rate on skilled labor

tr_i : Tax rate on land and natural resources

tc_i : Tax rate on commodity

A_i : Efficiency parameter for CES production function

AR_i : Efficiency parameter for CES import demand function

αT_i : Efficiency parameter for CET export supply function

e_i : Elasticity of substitution parameter at the first nest of the production process

se_i : Elasticity of substitution parameters at the middle nest of the production process

ge_i : Elasticity of substitution parameters at the upper nest of the production process

ςT_i : Elasticity of substitution parameter for the CES import demand function

ρT_i : Elasticity of substitution parameter for the CET export supply function

γT_i : Distribution parameter for the CET export supply function

φT_i : Distribution parameter for the CES import demand function

μ_i : Substitution parameter for the nested CES production function

ρ_i : Substitution parameter for the nested CES production function

θ_i : Substitution parameter for the nested CES production function

δ_i : Distribution parameter for the nested CES production function

β_i : Distribution parameter for the nested CES production function

γ_i : Distribution parameter for the nested CES production function

αI_i : Distribution parameter for Investment

αG_i : Distribution parameter for Government

αC_i : Distribution parameter for consumption

mps : Marginal propensity to save

io_{ij} : Input – output coefficient

π : Profit

Sec 1 : Crop production

Sec 2 : Livestock production

Sec 3 : Forestry

Sec 4 : Fishing

Sec 5 : Quarrying

Sec 6 : Manufacturing

Sec 7 : Electricity – water

Sec 8 : Construction

Sec 9 : Wholesale and retail trade

Sec 10 : Hotels and restaurants

Sec 11 : Transport and communications

Sec 12 : Financial institutions

Sec 13 : Dwellings, business and personal services and public services

Chapter 1

INTRODUCTION

Economic isolation from the world economy due to the current political situation has led to limited production capability in North Cyprus. Due to market inefficiency in goods and factors market, North Cyprus economy fails to utilize its resources and thus, it has been extremely difficult to achieve its economic goals. Besides the inefficiency in goods and factors markets, the economy is highly dependent on the Turkish economy. North Cyprus uses the Turkish Lira (TL), supplied by the Central Bank of Republic of Turkey and dependence on TL causes macroeconomic instability; a sudden change in interest rates and inflation directly affects the growth and stability of the Turkish Cypriot economy. The Central Bank of North Cyprus has a critical role to play in the regulation of the country's financial institutions although it is dependent on Turkey's economy. The economy exhibits characteristics of small-island economies that experience very high transportation costs, where market competition is frequently lacking in international transport, hence, monopoly charges may apply to such transport. *(Tisdell 2006)*

Since 1974, the North part of the Island has been partially isolated from the world economy. There have been many attempts to re-unite Cyprus within the last decade but attempts to re-unite the Island have failed because of political dispute between the Turkish and Greek Cypriot leaders. The unrecognized status of North Cyprus as a sovereign country still continues. In April 2003 the borders between North and South

Cyprus were opened and since then the crossing of the borders (Green Line) between South and North Cyprus, became possible. Tourists of both communities started travelling daily through the check points. Although many attempts have failed to re-unify the Island, the easing of restrictions on movement along the Green Line that has been enjoyed since April 2003, has greatly affected the both economies on the Island. Expenditures accelerated stimulating the demand-driven factors, and due to improvements in the investment climate in North Cyprus, economy experienced an enormous growth trend in the periods of 2004 to 2007, by almost 10 percent. However, easing of restrictions on movement along the Green Line has a significant impact on savings and investment. The theoretical models predict that host country's savings is positively related to the current incomes of the migrant workers as well as native's household income. *(Osili 2007)* Table A2 (Appendix A) presents the main macroeconomic performance indicators as percentage of real GDP between 2000 and 2010. As indicated in Table A2, there have been significant developments between 2000 and 2004 but then performance of the North Cyprus economy started to slow down after 2007.

In North Cyprus, the growth trend between 2003 and 2007 was partly due to the investment climate and the positive expectations on re-uniting Cyprus within the European Union perspective framework. In these periods the real GDP and GNP grew between 10.6 and 14.2 percent and 11.4 and 15.4 percent respectively according to State planning Organization of North Cyprus. As an important element of the sustainable development process, investment growth in real GDP increased by 23.66 percent in 2007 then the share of investments in real GDP was only 18.70 percent in 2010. In order to maintain a healthy rate of growth in economies, an

investment rate of at least 25 percent is required and the rate of capital formation in the form of equipment investment determines the rate of a country's economic growth. (*Wen 2001)*

However, the share of foreign trade balance in terms of real GDP is widened as a result of greater import demand. Greater government income has provided for an expansion of current public expenditures and public investments, but public savings as a share of real GDP has remained stable, as public expenditures have increased in parallel to the public revenues. Investment expenditures of the private corporations have increased by more than consumption expenditures between 2004 and 2007, there was an improvement in private sector savings designated to finance investments.

Positive developments and growth in physical production during the 2003 and 2007 period has also been due to an increase in foreign demand. The construction sector has increased its share in total real GDP due to acceleration in infrastructural investments. Apart from the larger amount of new investments in tourism sector, renovation, local and foreign demand for dwellings the higher public infrastructural investments have all caused the rapid growth in construction and related sectors. Although macro-economic performance of the North Cyprus economy has improved, this is not an indication whether economic well-being has improved or not since 2003. Investments' contribution to GDP only concerns the spending made in one year. For this reason, investments only to a limited extent, account for the gains and losses in natural resources, economic and social assets, that is important aspects from a long-term sustainable development perspective.

Turkish Cypriot workers move daily across the borders to take opportunities in South Cyprus labor market. Turkish Cypriot worker's participation in the South Cyprus increased by 51 percent from 2003 to 2004 according to Social Insurance Service in South Cyprus. And thus, this has led a large flow of external income, coming from the South Cyprus through migrant remittances in the North. On the other hand, North Cyprus economy not only experienced out-migration but also labor market conditions have changed due immigrant workers coming from Turkey since 2004.

Changes in labor market affect the economic conditions and migration is a contentious issue in the industrialized countries of the world. Many of the key issues regarding the impacts of migration concerns economics and thus economic consequences of migration varies by time and by place and can be either beneficial or harmful. There are great amount of empirical work in the literature analyzing the implications of migration on economic growth, capital accumulation, consumption, public finances, and current account; findings contradict among the researches. Most of the researches pay attention on the consequences of immigration or emigration separately using different techniques where most of the studies rely on econometric analysis or partial equilibrium models.

General equilibrium models are widely used when it comes to show the distributional effects of changes in economic circumstances. Although Computerized General Equilibrium (CGE) models have a great applications in literature, their usage is limited to an extent that they require consistent input-output data, national accounts data and information on elasticity of substitution parameters for the factor inputs as well as for transformation parameters. Therefore, most of the CGE models that are

constructed to analyze the migration issues use a simple CGE framework such as 2-factors and 2-goods.

For the North Cyprus economy, in order to analyze the economy-wide and combined effects of out-migration, remittances resulted and immigration, a comprehensive single country CGE model was needed. One of the characteristics of the CGE models is that, they rely on a consistent Social Accounting Matrix (SAM) which link all the model variables and parameters together, and it is derived using input-output tables and national accounts data.

A SAM which is based on consistent input-output tables for the year 1998 is first constructed and then using the SAM, the first Computerized General Equilibrium (CGE) Model for the North Cyprus economy is built. The CGE model is the first comprehensive model describing the economic activities in North Cyprus, and it is constructed as follows: Production process follows a 3-level nested Constant Elasticity of Substitution (CES) function at the primary production level and Leontief structure at the intermediate level. Households demand commodities and services given that their utility is maximized; firms' investment demand is determined endogenously through a Cobb-Douglas function, government sector spends the fixed proportion of their revenues on commodities, and the external trade is determined by the CES import demand function with Armington assumption and Constant Elasticity of Transformation (CET) export supply function.

In this thesis I built a model and used it to analyze the consequences of remittances daily out-migration and immigration, on economic well-being in North Cyprus. In

order to analyse the implications of labor mobility and remittances resulted, I performed three simulations. Findings suggest that with the first simulation 10 percent reduction on unskilled labor supply accelerates the demand side of the economy, worsening the supply side. With the second simulation I investigated the impact of remittances only keeping the labor supply unchanged, in other words, reduced Turkish Cypriot unskilled labor supply is replaced by the foreign workers. This, led to an improvement on the supply, real output increased by 2.22 percent. However, with an additional external income, final demand increased and thus GDP increased. With higher demand, domestic prices increased, making domestic goods more expensive as compared to the imported commodities. Therefore imports increased, widening the trade deficit.

Final simulation was based on a restriction over the unskilled immigrants. I performed this simulation to keep the wages in initial equilibrium. When supply of foreign workers is controlled only 6.80 percent foreign workers of the initial domestic unskilled labor supply brings the labor market back to the initial equilibrium level.

The structure of the thesis is as follows. The thesis consists of six chapters. First chapter, which is also the current chapter, is the introduction. In this chapter motivation and the purpose of this study are emphasized. Introduction chapter is followed by a chapter on literature review. In Chapter 3, methodology and the CGE model for the North Cyprus economy is described. In Chapter 4, I analyzed the implications of unskilled labor outflow and remittances resulted on the demand and supply side of the North Cyprus economy. Chapter 5 is on analysis of strategic

economic policies on wages, capital price and land price. In this chapter I performed three simulations to evaluate the implications on the North Cyprus economy. Final chapter is the conclusion.

Chapter 2

LITERATURE REVIEW

Effectiveness of migrant remittances has received a great attention in the literature and many of the researchers analyzed the implications of migrant remittances on economic development, labor market outcomes and competitiveness. *(Airola 2007; Barajas at al.2011; Jansen 2011)* Consequences of migrant remittances vary with the characteristics of migrant workers that affect the productivity performance and thus many studies in the literature focus on the migration impact on productivity. It is empirically suggested that in the long run, immigration has a positive impact on the receiving countries' economies, if the skills are complement with the other factors of production even though immigration reduces the wage earnings of the native workers. Despite the positive influence, if migrant workers are substitute with the existing factors of production, migration affect the receiving country's productivity negatively. In such cases, immigrants significantly increase costs of employment as they find it difficult to adapt in the receiving country's labor market with a lack of skills they have.

The implications of migration and remittances resulted by migration has received increasing attention for decades. Remittances brought by the migrant workers are a big source of foreign exchange earnings and workers' remittances are important for financial inflow since it determines the state of welfare in the host countries. *Iyjaz and Aftab (2011)* Moreover, remittances affect competitiveness through other

channels. An increase in remittances inflow associated with an out-migration of workers, decreases domestic labor force; moreover, households receiving remittances may use higher income to reduce work effort, increase leisure time and time spent on education. All these factors reduce the labor supply further. In an economy with heterogeneous skills, due to complementarities between the skills and services produced by both natives and immigrants, natives respond to immigration by moving around and upgrading their jobs. Therefore, large inflows of worker remittances poses macroeconomic challenges for the recipient countries; worker remittances challenge the equilibrium mechanism as large inflows of worker remittances led to an appreciation of the equilibrium real exchange rate undermining the international competitiveness of domestic production. *Barajas at all. (2011)*

Labor supply reductions also increase the wage level, which increase cost of production and thus reduce competitiveness. Study by *Ottaviano and Peri (2007)* analyzed the consequences of migration on wages, consumption and housing prices of natives using the supply driven component of immigration in a simple general equilibrium framework. Their findings showed positive and significant wage and housing price effects caused by immigration.

"Productivity differential can be attributed through the differences in labor force composition already exists in countries." *Borjas (1994); Okkerse (2005)*, taking labor heterogeneity and all the channels into account built a CGE model to stimulate the effect of immigration in Belgium. Results show that although immigration is macro-economically beneficial, there is significant adverse effect of immigration at a distributional stage.

Throughout my research on economic impact on migration, most of the researchers pay attention to the potential adverse effect on labour market outcomes of native-born workers which immigration lowers the wage rate and displace native-born workers in employment rather than paying attention to the benefits of immigration. It has been empirically evidenced that, economic welfare increases in the host countries if immigrants complement some of the existing factors in production, causing the local factors to benefit from immigration.

There are different approaches or models that are used to analyse the impact of immigration. Partial equilibrium macroeconomic models are very common in the literature that uses econometric techniques to analyse the consequences of migration on both receiving and sending countries. Macroeconomic models, (simple general equilibrium) in which standard input-output tables with fixed coefficients are used, focuses on the demand side of the economics only. General equilibrium models (CGE) have wider applications in literature. These models are numerical and are based on consistent input-output tables.

There are also structural models whose equations are derived from the optimization behaviour of households, firms and other agents represented in the economy. Such models link factor incomes and expenditures, and model the substitution process in production and consumption, while taking market clearing conditions into account. General equilibrium models in the literature usually are applied to implement the various external shocks on economic variables and they are mostly divided into two categories; partial and general equilibrium models.

2.1 Partial Equilibrium Models

Partial models use standard production theory with 2 factors of production and usually production with labor and capital inputs are represented by Cobb-Douglas production functions assuming constant returns to scale exhibits in production. *Borjas (1995) Most* of the partial equilibrium models use econometric techniques to measure the degree of complementarities and substitutability between the immigrant and native workers. Their findings suggest that if immigrants are substitute to the other production factors, there can be harmful effects on the economies of receiving countries. Conversely if immigration can increase the earnings and also employment opportunities for natives if immigrants are complements with the existing production factors in host countries. And this increase in immigration benefits the economies of receiving countries in the long run. *Borjas (1994)* The paper by *Mishra (2005)* used an econometric model to estimate the effect of emigration on the national wages in Mexico. The analysis showed that there is a strong and positive relationship between emigration and wages in Mexico. Findings show that, the impact of emigration on wages has important implications over the wage inequality across schooling groups as well as within the national income distribution between labor and other factors.

In a partial equilibrium model of a small, open, price taker economy where free trade exists with the rest of the world, *Michael (2006)* investigated the welfare consequences of immigration policies. The study takes labor heterogeneity into account assuming that skilled workers are more productive and capital is perfectly mobile internationally. When migration is permanent, immigrants do not remit any of their income earnings from the host country to the source country. Therefore it was suggested that the welfare effect on natives from a change in immigration is linked to

the type of labor, whether this type of labor is a net contributor or beneficiary in the receiving countries. Skilled immigrant workers who are assumed to be more productive are net fiscal contributors, but are very likely to reduce the welfare of skilled native workers. In an economy with workers of different skills, natives respond to the inflow of immigrants by moving around and upgrading their jobs, as there are complementarities between the skills and services produced by natives and immigrants. Although immigrants have a small and negative effect on wages of unskilled natives, this negative effect is partly compensated by the complementarities within the skill groups. *Ottaviano and Peri (2006)* Using the supply driven component of immigration showed that unskilled immigrants increase the demand for housing in the same types of neighbourhoods as unskilled natives.

Partial equilibrium (PE) models only take some parts of the economy into consideration therefore their link with the other parts of the economy is limited. For example PE models examine the effects of an exogenous shock in the one particular sector related to the shock; ignoring the implications in other markets or sectors.

2.2 General Equilibrium Models

The economic impact of migration depends on the economic characteristics of the sending and receiving countries and the measured impact of immigration on the host and sending country economies fluctuates widely from one study to another. To study the implications of migration, the one should take all the channels of the structure of economies into account. CGE models corporate the links between the factor markets, goods markets and service markets and enable us to study the interrelations of all the parts of the economy. Therefore it is an appropriate tool for policy makers or academics to analyse the impact of various shocks on the economy

as a whole. The CGE models are widely used to quantify the effects of migration on income and welfare of different types of households.

In a simple theoretical model, *Brezis and Krugman (1993)* investigated the long run and short run impact of large scale of immigration on real wages. In their simple model, there are two factors of production namely capital and labor. Capital and labor are combined to produce "inputs", which are then used to produce both final goods non-traded intermediate goods, and they are subject to internal economies of scale; the production function that is used in their model is, Cobb-Douglas. They assume monopolistically competitive market where many differentiated goods are produced. Their findings show that, an exogenous increase in the labor force first decreases the real wages, but then due to a surge in investments, wages gradually increase. Eventual impact on real wages is positive since enlargement of the domestic economy allows a wider range of production and thus, real wages rises. The authors conclude that, long run economic opportunities depend on the increase in the labor supply and in the capital stock.

Williams (2003) contributed to the debate over immigration using three-region, three factor, and six-good computable general equilibrium model. The model was constructed as follows; for the one type of producer, capital is explicitly included in the nested CES type production function together with unskilled labor. Then for the second type of producer, again CES type production function is used where skilled labor and composite of unskilled labor and capital are used as inputs to the production function. Two types of households exist in the model namely, rich and poor and they demand the two composite traded and non-traded goods.

The author observed that with immigration, there is a pronounced gain in the utilities of unskilled workers since free migration increases the wages of unskilled workers seven times or more. Secondly, free migration not only increases the wages of those who immigrate, but also increases the wages of those who remain in their countries since wages tend to rise due to the reduction of workforce in the sending country.

CGE models are designed in a way that, by taking the impact of changes in one particular determinant into account, they examine the outcome of disturbance in the other markets that leads to changes in demand and supply as well as changes in equilibrium conditions in other markets.

Chapter 3

METHODOLOGY AND CGE MODEL

This chapter explains how a CGE Model is built for the North Cyprus economy. The single-country general equilibrium model in a perfectly competitive environment is constructed as follows. There are 2 type of goods or services “tradable and non-tradable”, 4-factors of production for the 13-industries and mathematical formulation of the model consists of 4-building blocks - a production-and-commodity block, an institution block, represented by households, firms, government and the rest of the world; price block, and finally system constraint block.

In this chapter, first, a production and commodity block of the model is explained where output consists of two parts. The first part is the value created by intermediate goods and services, used through consistent input-output coefficients and there is no substitution between the intermediate inputs used. The second part comes from the value added which is the value created by the factors of production. There are four factors of production; unskilled labor, capital, skilled labor and land, represented by a 3 level nested CES production function. Throughout the second part of production, substitution among the primary inputs is allowed. Skilled labor (H) and unskilled labor (L) is mobile with some constraints between the industries and capital (K) is mobile both between industries and internationally. Land, including natural resources (R) is truly fixed and immobile.

Within the institution block, behaviour of households, firms, government and rest of the world is explained; households make preferences and their behaviour is represented by a Cob-Douglas utility function, firms invest on physical capital, government collects revenue through indirect and direct taxes and government spend fixed proportion of their revenues on commodities and transfers. Regarding the rest of the world, the imports are derived through a CES function implying the Armington assumption and exports are supplied through a CET function.

In each part, system constraint blocks are also explained. System constrains such as zero profit conditions at each institution, market clearance conditions, and the trade balance are all determined in the model. Total savings are equal to the total investment, government savings and foreign savings are exogenously fixed. And thus, public sector budget balance and trade balance occur respectively. Finally, the nominal exchange rate is exogenously given and it is kept fixed.

Through the price block in the model, factor costs are carried to the market prices by applying the appropriate tax rates for each commodity within each industry. There are three types of taxes that are calibrated in the model. Value added tax on the household's preferences, indirect taxes of factors of production and import duties. A Laspayers price index is used to transform the nominal variables into the real variables. Through the optimization process, prices are therefore determined within the model.

3.1 Production

Production behaviour is not purely a technical relationship, since production functions which firms use, not only involve turning inputs to output but also involve allocating the resources efficiently in the production process. The production functions we are using in this model are key determinants of how those resources are allocated, what determines the level of output that firms supply, and what are the costs incurred in the production of goods and services.

CGE models are formulated in a way that takes all those interrelations into account and it involves a series of markets for goods and services. The usual assumption made in CGE modelling is that, "inputs used" are strictly complementary and there is no substitution between them, which is captured by the Leontief production function. However, to allow imperfect substitution among the factors of production value added is generated by multiple production functions which is referred to as "3-level nested CES production function" throughout the thesis. In the first nest of the production function, unskilled labor (L) enters the production function together with capital (K). Then they jointly enter the production function together with skilled labor (H) at the second nest of the production. This process allows skilled labor substitution with the composite factors (J). This means; if capital inputs are complements in production with un-skilled labor then it will require more capital to go along with more unskilled labor and thus, there will be a bigger scale effect. Finally, including productive land (R) into our production function as a separate (substitute) factor-endowment is needed as the value of land is very sensitive to the changes of economic circumstances in Cyprus.

3.1.1 Production Represented by Leontief Function

The CGE model is constructed for the year 1998, the only period for which the consistent input-output data is available. Nevertheless, regarding Leontief's main assumption without loss of generality it can be assumed that the technical structure is applied for at least another ten years. For the CGE models, the use of a micro-consistent benchmark dataset in the form of "SAM" (Social Accounting Matrix) specifies the aggregate factor endowments, the outputs by the 13-industry groups, factor usage by production activity and the input-output structure. The SAM is shown in Table A1. Production is characterized by the constant technical coefficients, io_{ij}, which are obtained by dividing each element of the transaction matrix, x_{ij}, units of good i used by industry j, by the total output XD_j of each industry j such that;

$$a_{ij} = \frac{x_{ij}}{XD_j} \quad i, j = 1,\ldots,13$$

So each column of the newly created matrix comprises input coefficients of one particular sector j. Thus, the entire matrix of technical coefficients "A matrix" is designed to summarize the production process of the entire economy in the form of goods that flow into and out of each industry.

3.1.2 Production Represented by 3-level nested CES Function

At this stage, a 3-level nested CES production function is used. Nested CES functions have a wide application in empirical work on production process. The example found in literature is by *Khan and Rafiq (1993*). These authors using 3-level

nested CES function, estimated a production function for the manufacturing sector of Pakistan with four inputs; labor, capital, imported raw materials and bank credits. Then they calculated the elasticity of substitution between these factors of production.

3-level Nested CES function has two important features; it allows us to build a model that characterizes the structure of the North Cyprus economy. Second, the CES production function which involves four inputs has some disadvantages in terms of estimating its elasticity of substitution parameters. According to Neoclassical production theory, it is possible to substitute one factor of production for another (depending on their production function) and some of the factors of production can be characterized as either substitutes or complements depending on how they enter the production process. *(Sato and Koizumi 1973)* Using the production and cost functions the elasticity of substitution can be defined. But, with $n-$factors case, measurement of elasticity of substitution is analogous since measuring elasticity of substitution by holding other factors fixed does not represent the full degree of substitution possibilities present in the production function. Therefore, Samuelson measure of elasticity of substitution shown below is not relevant in this world of $n-$ factors of production.

$$s_{ij} = -\frac{f_i/f_j}{\chi_i/\chi_j}\frac{d\left(\chi_i/\chi_j\right)}{d\left(f_i/f_j\right)} \gtrless 1 \ ,$$

Simply, s_{ij} measures how fast the ratio of two inputs changes when the marginal rate of substitution between them changes; where measurement of the degree of

responsiveness to changes in parameters is essential in any science. $(1 \le i, j \le n)$ for $i \neq j$

When $n-$factors present in production functions, it is essential that we consider "the partial elasticity concept." *(Sato and Koizumi 1973)* The authors emphasized that "the relative share of one factor increases or decreases as the quantity (price) of *another* factor increases depending on whether the partial elasticity of complementarities (substitution) between two factors in question is greater or smaller than unity. Therefore, defined the partial elasticity of complementarities between factors χ_i and χ_j are shown as;

$$c_{ij} = \frac{ff_{ij}}{f_i f_j}, \quad i \neq j$$

and, partial elasticity of substitution between factors χ_i and χ_j are;

$$\varepsilon_{ij} = \frac{gg_{ij}}{g_i g_j}, \quad i \neq j$$

Both of the elasticities possess the symmetry property where

$c_{ij} = c_{ji}$

$\varepsilon_{ij} = \varepsilon_{ji}$.

However, $f(\chi_1,...,\chi_n)$ is homogeneous of degree one, which implies a constant returns to scale, and f_i f_j and g_i g_j respectively are the first partials of the production function and the cost function with respect to the specific factor input

price while holding other factors constant and it has a homogeneous of degree zero property.

Firms, operating under perfect competition in both production and factor markets face the following cost function;

$$TC = \sum_{i=1}^{n} p_i \chi_i$$

where the p_i's are constant factor prices for the $n-$factors production process.

In order to derive the factor demand functions, which are essential for our model, total cost is minimised subject to the production function at each nest.

The multiple nested CES production functions process is shown in Figure 1.

Figure 1. 3-level Nested CES Production Process

3-level Nested CES production function is divided into 3 sub-categories to enable us to consider factor specific elasticity of substitution parameter for each pairs. At the first level (the lowest nest), production function J_i represents composite output which is produced using only capital and unskilled labor. In order to derive factor demand equations total cost of factor inputs is minimized subject to the composite production function. Factor demand equations are derived through the first order conditions.

At the second level (the middle nest) of production process, composite input J_i and skilled labor enter the nested CES production function as substitute inputs. Finally, value added is formulated through the following upper nest CES function.

The CES production function with four primary factors of production is given by

$$XD_i = A_i\left\{\delta_i\left[\underbrace{\left(\beta_i\underbrace{\left[\left(\gamma_i.K_i^{\mu_i}+(1-\gamma_i)L_i^{\mu_i}\right)^{1/\mu_i}\right]}_{J_i}{}^{\rho_i}+(1-\beta_i)H_i^{\rho_i}\right)^{1/\rho_i}}_{G_i}{}^{\theta_i}+(1-\delta_i).R_i^{\theta_i}\right]^{1/\theta_i}\right\}$$

Where

$i = 1,...,13$

3.1.2.1 Production at the Lowest Nest

At this stage the cost of production using unskilled labor and capital is minimized subject to the production function shown below.

$$TC_{K,L} = k_i.K_i + l_i.L_i$$

$$J_i = \left(\gamma_i K_i^{\mu_i} + \left(1-\gamma_i\right) L_i^{\mu_i}\right)^{1/\mu_i}$$

where $\mu_i = \dfrac{e_i - 1}{e_i}$

Factor demand equations of the lowest nest are;

$$K_i^* = \frac{\gamma_i^{e_i}.k_i^{-e_i}}{\left(\gamma_i^{e_i}.k_i^{1-e_i} + \left(1-\gamma_i\right)^{e_i}.l_i^{1-e_i}\right)^{-(e_i/1-e_i)}}.J_i$$

$$L_i^* = \frac{\left(1-\gamma_i\right)^{e_i}.l_i^{-e_i}}{\left(\gamma_i^{e_i}.k_i^{1-e_i} + \left(1-\lambda_i\right)^{e_i}.l_i^{1-e_i}\right)^{-(e_i/1-e_i)}}.J_i$$

Substituting optimum combinations of capital and unskilled labor in the lowest nest production function gives composite input J_i

Then factor demands, capital and unskilled labor are substituted into the cost function which yields the "composite price" for composite inputs.

$$j_i = \left(\gamma_i^{e_i}.k_i^{1-e_i} + \left(1-\gamma_i\right)^{e_i}.l_i^{1-e_i}\right)^{1/(1-e_i)}$$

3.1.2.2 Production at the Middle Nest

Optimum combinations composite input of unskilled labor-and-capital enters the CES production function together with the skilled labor, then their cost is minimized subject to the production function.

$$TC_{J,H} = j_i.J_i + h_i.H_i$$

$$G_i = \left(\beta_i J_i^{\rho_i} + (1-\beta_i) H_i^{\rho_i}\right)^{1/\rho_i}$$

where, $\rho = \dfrac{se-1}{se}$

Cost minimization process yields the optimum allocation of skilled labor resource;

$$H_i^* = \frac{(1-\beta_i)^{se_i} . h_i^{-se_i}}{\left(\beta_i^{se_i} . j_i^{1-se_i} + (1-\beta_i)^{se_i} . h_i^{1-se_i}\right)^{-(se_i/1-se_i)}} . G_i$$

Finally, substituting optimum use of factors into the cost function yields the second composite input price equation;

$$g_i = \left(\beta_i^{se_i} . j_i^{1-se_i} + (1-\beta_i)^{se_i} . h_i^{1-se_i}\right)^{1/(1-se_i)}$$

3.1.2.3 Production at the Upper Nest

Output is determined by the following function;

$$XD_i = A_i \left(\delta_i G_i^{\theta_i} + (1-\delta_i) R_i^{\theta_i}\right)^{1/\theta_i}$$

where $\theta_i = \dfrac{ge_i - 1}{ge_i}$

Minimizing the cost function,

$$TC_{G,R} = g_i . G_i + r_i . R_i$$

Subject to the production function, optimum factor demand function for land is also derived;

$$R_i^* = \frac{\left(1-\delta_i\right)^{ge_i}.r_i^{-ge_i}}{\left(\delta_i^{\,ge_i}.g_i^{1-ge_i}+\left(1-\delta_i\right)^{ge_i}.r_i^{1-ge_i}\right)^{-(ge_i/1-ge_i)}}.XD_i$$

where, the efficiency parameter of the production function is calibrated as;

$$A_i = \frac{XD_i}{\left(\delta_i G_i^{\frac{ge-1}{ge}}+\left(1-\delta_i\right)R_i^{\frac{ge-1}{ge}}\right)^{ge_i/ge_i-1}}$$

Intermediate inputs used and primary inputs are combined with Leontief assumption and zero profit conditions are set for the analysis. On the other hand, for all four factors, factor supply equals factor demand ensuring that there are neither market surpluses nor shortages.

Considering both first and the second parts of the production process, profit function is defined as;

$$\Pi_i = P_i.XD_i - \left[\left(k_iK_i + l_iL_i + h_iH_i + r_iR_i\right) + \sum P_{ij}.io_{ij}.XD_i\right]$$

To obtain the zero profit condition K, L, H and R are substituted into the profit function above and setting the first derivatives equal to zero yields;

$$\frac{\partial \Pi}{\partial XD} = 0 .$$

Constraint over the factors of production;

$$\sum L_i = LS_i$$

$$\sum H_i = HS_i$$

$$\sum K_i = KS_i$$

$$\sum R_i = \overline{RS_i}$$

Through these conditions, markets clear for all factors of production.

3.2 Behaviour of Households

Preferences of the households are represented by Cobb-Douglas utility function and there is only one type of household who demand goods and services. Households have the following utility function;

$$U = \sum_{i=1}^{n} C_i^{\alpha_{c_i}} \qquad \text{where,} \quad i = 1,...,13$$

Household's income comes from the factors of production and from the government transfers shown by the following income equation;

$$MY = lw.LS + hw.HS + kw.KS + rw.RS + \overline{Trans} + \overline{REMIT}$$

Households save fraction of their income, their disposable income is derived through the following equations.

$$SH = mps.\left(MY - \left(tm.MY\right)\right) + mps.\overline{REMIT}$$

Where,

$$mps = \frac{SH}{\left(MY - TRMZ\right)}$$

Finally, disposable income equation is derived as;

$$M = (1 - tm).MY - SH$$

Households then maximize their utility subject to the disposable income and derived demand for commodities is shown as;

$$C_i = \frac{1}{PC_i}.\alpha_{c_i}.M$$

Consumers spend their disposable income on commodities and save the fraction of their income. Private / household savings derived endogenously ensures that difference between income and expenditures equal private savings. This constraint is set by the following equation;

$$SH = MY - TRMZ - M$$

3.3 Investment Demand

Private and public sectors demand physical capital such as factories, equipment and machinery to make production. They finance their investment purchases from savings. Therefore, in the model investment demand and inventories in each industry is obtained through a constrained optimization of investments subject to total savings. Optimization process yields the following investment demand and inventory demand equations respectively.

$$I_i = \frac{\alpha_{I_i}.(S - INV)}{PC_i}$$

$$INVENT_i = \frac{\alpha_{INV\,i}.S}{PC_i}$$

Where savings are;

$$S = SH + \overline{SG}.PCINDEX + \overline{SF}.\overline{EXR}$$

Where foreign savings are determined endogenously and it is kept fixed.

$$\overline{SF} = \sum PWIMZ.IM_i - \sum PWEZ.EX_i - \overline{REMIT}$$

Gross fixed capital formation is then determined through;

$$DI_i = \sum_{i=1}^{n} PC_i.I_i + INV$$

Where,

$$INV = \sum_{i=1}^{n} INVENT_i$$

3.4 Public Sector

Government collects direct and indirect taxes and spends the fixed proportion of the revenue on community services and consumption goods. Government also makes transfer payments and inclusion of the transfer payment is shown in income equation. In our model, government expenditures are exogenous, tax instruments are endogenous to reflect (increase) the revenues and thus, government balance remains fixed. Following equations represents the government's behaviour in the CGE model.

Tax revenues are;

$$TAXR = \sum PC_i.tc_i.C_i + tl_i.lw.L_i + th_i.hw.H_i + tk_i.kw.K_i + tr_i.rw.R_i + tim.PWIMZ.IM.EXR + tm.MY$$

Total Government spending;

$$EG = \sum_{i=1}^{n} CG_i + \overline{Transf}$$

Government budget balance;

$$TAXR = EG + \overline{SG}$$

Where, government savings are exogenously fixed.

3.5 International Trade

Foreign sector for imported and exported commodities are represented with CES and CET functions respectively and demand for imports and supply of exports are derived through optimization.

3.5.1 Demand for Imported Commodities

Demand for imported commodities is represented by CES function with Armington assumption to identify traded goods and services in-use, separately. The assumption of homogenous goods is given up by introducing product differentiation through their country of origin on import side, following the Armington assumption. This assumption is widely used in the CGE models to define demand for domestically produced commodities, as well as demand for imported goods when the products are nationally differentiated. Following *Lloyd and Zhang 2006*, when imports originate in more than origin country, it is assumed that imports from different countries are differentiated from each other and form a group that is separable from the domestically produced products. Therefore, it make sense if we assume that, domestically produced and imported inputs used in one industry are imperfect but close substitutes, nested in a production function for the industry group.

With the Armington structure, two-stage budgetary allocation procedure is assumed. Firstly, budget is allocated among the domestically demanded commodities and then expenditure on each commodity is allocated between domestic and imported commodities. In order to derive the demand for domestic and imported commodities, firms minimize their total cost subject to their CES type production function.

$$TC_i = PIM_i.IM_i + PDD_i.XDD_i$$

$$SX_i = AR_i\left[\varphi T_i.IM_i^{-\rho m} + \left(1-\varphi T_i\right)XDD_i^{-\rho m}\right]^{-\frac{1}{\rho m}}$$

and $\quad \varsigma T_i = \dfrac{1}{1+\rho m_i}$

Solving the first-order conditions yields the following domestic and imported commodities.

$$XDD_i = \left(1-\varphi T_i\right)^{\varsigma T_i}.PDD_i^{\left(-\varsigma T_i\right)}.\left[\left(1-\varphi T_i\right)^{\varsigma T_i}.PDD_i^{\left(1-\varsigma T_i\right)} + \left(\varphi T_i\right)^{\varsigma T_i}.PIM_i^{\left(1-\varsigma T_i\right)}\right]^{\frac{\varsigma T_i}{\left(1-\varsigma T_i\right)}}.\frac{SX_i}{AR_i}$$

$$IM_i = \left(\varphi T_i\right)^{\varsigma T_i}.PIM_i^{\left(-\varsigma T_i\right)}.\left[\left(1-\varphi T_i\right)^{\varsigma T_i}.PDD_i^{\left(1-\varsigma T_i\right)} + \left(\varphi T_i\right)^{\varsigma T_i}.PIM_i^{\left(1-\varsigma T_i\right)}\right]^{\frac{\varsigma T_i}{\left(1-\varsigma T_i\right)}}.\frac{SX_i}{AR_i}$$

3.5.2 Supply for Exported Commodities

Each industry produces a composite commodity XD_i which can be exported and/or sold domestically in the market. Export markets include all regions within the country and international markets.

In CGE analysis, exports and domestically sold products are assumed to be differentiated by market (with respect to their prices), and relationship between them is represented by a constant elasticity of transformation (CET) function. CET function describes the market transformation process and each firm allocates its output between the domestic and export markets. Domestic supply function for goods is derived from the first order conditions; maximizing revenue, subject to the

given output level with the CET function. And thus, for given domestic and export prices firms maximize total revenue;

$$PDD_i.XDD_i + PE_i.E_i$$

Subject to

$$XD_i = \alpha T_i \left[\gamma T_i.E_i^{-\rho T_i} + (1-\gamma T_i).XDD_i^{-\rho T_i} \right]^{-1/\rho T_i}$$

where $\sigma T_i = \dfrac{1}{1+\rho T_i}$

Solving the first-order conditions and rearranging terms yields the following domestic and exported commodities:

$$XDD_i = (1-\gamma T_i)^{\frac{1}{1+\rho T}}.(PDD_i)^{-\frac{1}{1+\rho T}}.\left[(\gamma T_i)^{\frac{1}{1+\rho T}}.(PE_i)^{\frac{\rho T}{1+\rho T}} + (1-\gamma T_i)^{\frac{1}{1+\rho T}}.(PDD_i)^{\frac{\rho T}{1+\rho T}} \right]^{1/\rho T}.\frac{XD_i}{\alpha T_i}$$

$$E_i = (\gamma T_i)^{\frac{1}{1+\rho T}}.(PE_i)^{-\frac{1}{1+\rho T}}.\left[(\gamma T_i)^{\frac{1}{1+\rho T}}.(PE_i)^{\frac{\rho T}{1+\rho T}} + (1-\gamma T_i)^{\frac{1}{1+\rho T}}.(PDD_i)^{\frac{\rho T}{1+\rho T}} \right]^{1/\rho T}.\frac{XD_i}{\alpha T_i}$$

Zero profit condition for CES with Armington and CET functions is set as;

$$PX_i.SX_i = PIM_i.IM_i + PDD_i.XDD_i$$

$$P_i.XD_i = PE_i.E_i + PDD_i.XDD_i$$

Trade balance occurs when exported commodities and imported commodities are equal. In our model, in order to equate the exports to the imported commodities, foreign savings acts as a model closure and it is kept fixed. However, initial level of remittances is exogenously fixed and zero before the shock. This relation is captured by the following trade balance equation.

$$\sum_{i=1}^{n} PMW_i.IM_i = \sum_{i=1}^{n} PEW_i.E_i + \overline{SF} + \overline{REMIT}$$

3.5.3 System Constraint of the Model

Total domestic demand equals industry supply and the market equilibrium is represented by the following;

$$C_i + I_i + INVEN_i + CG_i + \left(\sum_{i,j} io\right).XD_i = SX_i$$

3.6 Data and Calibration

National accounts data of North Cyprus is widely used to determine the initial public spending, investment, consumption, export and import expenditures in the model. Direct taxes, foreign savings and transfer payments are also provided from the National Accounts and calibration technique is used in order to calibrate the rate of taxes. General Census data for the year 1996 provided detailed information on the number of employed people by literacy within each industry so that we determined the shares of the skilled and un-skilled employment and thus the shares are used to

calibrate some of the model variables. Distribution parameters are calibrated at each stage of the process and elasticity of substitution parameters are taken exogenously from the various resources. Calibrated parameters are shown in Tables A3 to A7 in Appendix A. Then the system is validated and the model was solved for the benchmark year without imposing any changes in the parameters or exogenous variables so that the optimal solution replicates the original values for the benchmark year. System constraints are satisfied through the optimization processes and finally, equilibrium conditions (Walrasian constraints) are set to equate demand and supply in both goods and factor markets. For the labor market, we assume there is no unemployment and thus, labor supply equals the labor demand. At the final stage to verify the reliability of the model homogeneity tests are applied.

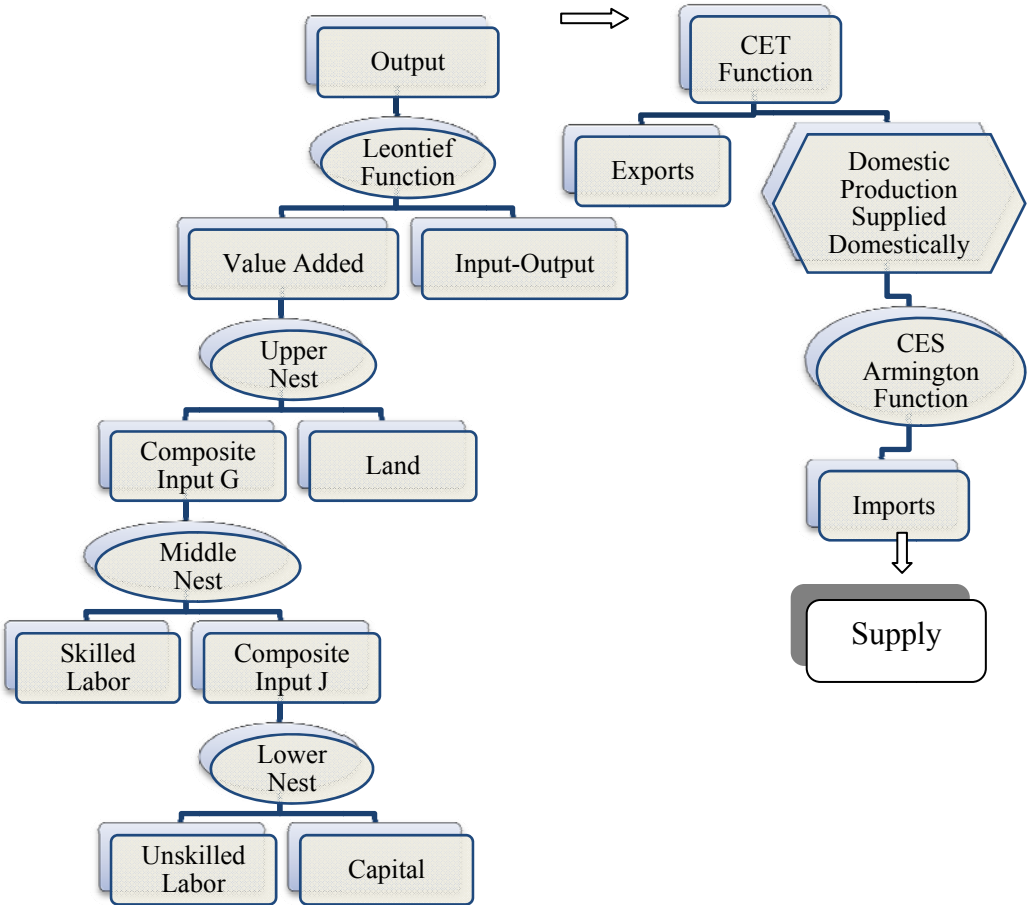

Figure 2. CGE Model - Production and Trade

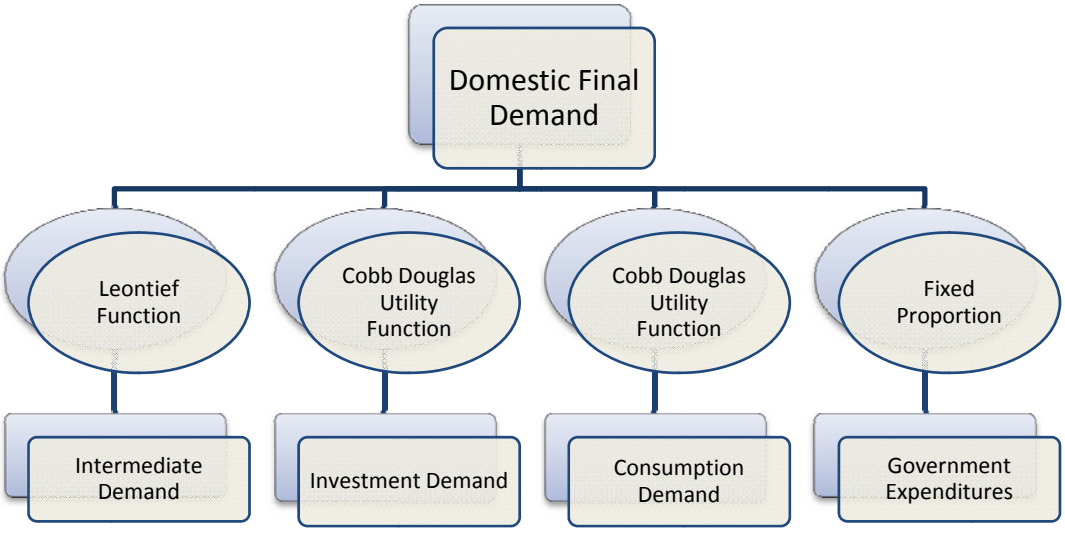

Figure 3. CGE Model – Domestic Final Demand

Chapter 4

EXTERNAL INCOME SHOCK ON ECONOMIC WELL-BEING THROUGH OUT-MIGRATION IN NORTH CYPRUS

This chapter presents the combine impact of external income due to out-migration on main macro-economic indicators such as savings, income, final demand, output and factor prices.

Base on the SIS (Social Insurance Service) of South Cyprus, around 2400 Turkish Cypriot workers are employed in the South Cyprus labor market and this constitutes to a 10 percent of the Turkish Cypriot unskilled workers in North Cyprus for the benchmark year, 1998. However, those workers who work in the South transfer earnings of 12.5 million TL, in the form of remittances to the North part of the Island.

Taking the available information into account, I performed a simulation that external income is increased by 12.5 million TL (in 1998 prices) while reducing supply of unskilled workers by 10 percent. In this scenario, I kept other factors such as capital, land, skilled labor supply and foreign exchange rate, public and foreign savings fixed but let the wages of unskilled and skilled workers, rent and price of capital to adjust.

Empirical findings show that external factor income and out-migration of unskilled workers induce increase in investments and savings which stimulates the demand side of the economy. In contrast due to a greater import demand, trade balance is deteriorated, real GDP decreased by 3.07 percent. Although a positive and significant influence on the demand side, supply side of the economy is worsened, output decreased by 3.78 percent in real terms.

Table 1. Impact of the Shocks on GDP and Expenditures

	Benchmark	Nominal Impact	% Change	Real Impact	% Change
Investment	49,779,827	51,192,385	2.84	50,007,214	0.46
Inventories	3,075,951	3,160,341	2.74	3,087,175	0.36
Consumption	188,419,094	196,020,741	4.03	191,482,603	1.63
Public Expenditures	62,884,655	65,785,620	4.61	64,262,597	2.19
Imports	163,766,671	179,537,497	9.63	175,380,968	7.09
Import duties	23,527,821	24,787,814	5.36	24,213,944	2.92
Exports	111,904,224	115,175,063	2.92	112,508,609	0.54
GDP	228,769,259	227,008,838	-0.77	221,753,285	-3.07

Source: Author's creation from GAMS output for the North Cyprus Economy

Investment expenditures and public expenditures increased by 2.84 percent and 4.61 percent respectively prior to the shock. Despite the positive growth in investments, public spending and consumption expenditures, GDP decreased by 3.07 percent due to 9.63 percent rise in imports. Table 2 shows the combine effect of the shocks on factor prices and consumer price index. It is observed that wages of unskilled and skilled workers increased by 9.37 percent and 3.57 percent respectively and price of capital increased by 1.42 percent. In our production function, capital and unskilled

labor are substitutes at the lowest nest. With an adverse supply shock on unskilled labor, the price of labor increases and that in turn affects the overall demand for labor. Here, scale effect must be taken into account since cost of producing output increases with higher factor costs. Depending upon the strength of the shock and factor elasticitities, the substitute factor's price may rise, fall or remain the same. In our model, demand for capital decreases and thus capital price remains almost the same. Demand for unskilled labor and capital determines the level of composite input J in our nested CES production function. With a higher unskilled labor wages, demand of composite input (J) falls. J is substitute with skilled labor at the middle nested CES production function, therefore, price for skilled labor increases. At the final and upper nest, composite input G and land are substitutes; with higher skilled labor wages, demand for composite input G falls, increasing the price for land. All factor prices increased in nominal terms, increasing the cost of production, deteriorating production resulting in 1.50 percent decrease in output.

Table 2. Changes in the Factor Prices Prior to the Shock

	Benchmark	Nominal Impact	% Change
CPI	1	1.024	2.37
Unskilled labor wage	1	1.093	9.32
Skilled labor wage	1	1.036	3.57
Capital return	1	1.014	1.42
Rent	1	1.025	2.45

Source: Author's creation from GAMS output for the North Cyprus Economy

Simulation results on main macro-economic variables are shown in Table 3. Results show that, households' income and their expenditures in real terms increased by 4.65

percent and 4 percent respectively. Total savings which are used to finance investment expenditures increased by 2.40 percent in real terms. However, 7.10 percent rise of imports and very little positive change in exports deteriorates the foreign trade balance. It is observed that trade deficit (as percentage in real GDP) increased by 21.23 percent.

Table 3. Savings, Investment and Income Effect

	Benchmark	Nominal Impact	% Change	Real Impact	% Change
Income	228,391,200	244,672,300	7.13	239,007,815	4.65
Expenditure	203,270,500	216,409,000	6.46	211,398,847	4.00
Savings	52,855,778	55,405,110	4.82	54,122,409	2.40
Private Saving	24,650,628	27,759,780	12.61	27,117,105	10.01
Foreign Saving	51,862,450	51,862,450	0	50,663,548	-2.31
Public Saving	-23,657,300	-23,657,300	0	-23,110,415	-2.31
Tax Revenue	50,226,930	53,127,890	5.78	51,897,910	3.33
Transfer pay.	10,999,555	10,999,555	0	10,745,279	-2.31
M-EX	51,862,447	64,362,434	24.1	62,872,359	21.23

Source: Author's creation from GAMS output for the North Cyprus Economy

Table 4 shows the changes in output, domestic output supplied on the domestic market and the domestic sales of composite commodities demanded by intermediate users and final demanders. As indicated, supply side of the Turkish Cypriot economy is worsened. Output decreased by 3.78 percent in real terms and there is also a negative effect on domestically sold output and composite commodities demanded in North Cyprus economy. Domestic output supplied domestically decreased by 5.46

while demand for composite commodities which include imported goods decreased by only 0.60 percent in real terms.

Table 4. Changes in Output, Domestic Supply and Demand of Composite Goods

		Nominal Impact	% Change	Real Impact	% Change
Output (XD)	377,115,512	371,440,999	-1.50	362,854,412	-3.78
Domestic output supplied domestically (XDD)	265,211,271	256,668,113	-3.22	250,734,726	-5.46
Domestic Sales of Composite Commodities (SX)	452,505,813	460,420,502	1.75	449,776,979	-0.60

Source: Author's creation from GAMS output for the North Cyprus Economy

Simulation results showed that external factor income and out-migration of unskilled workers induce increase in investments and savings which stimulates the demand side of the economy. In contrast due to a greater import demand, trade balance is deteriorated, real GDP decreased by 3.07 percent. Although there is a positive and significant influence on the demand side, production is worsened, output decreased by 3.78 percent in real terms.

Remittances in North Cyprus positively and significantly affect savings and investment. But it is also observed that due to out-migration (emigration) unskilled

labor outflow led to an income loss and thus output decreased worsening the supply side of the North Cyprus economy. However, as mentioned before this outflow is replaced by foreign unskilled workers, mainly from Turkey. Therefore further analysis is also needed to evaluate the changes in labor market considering such labor inflow under the circumstances that capital is mobile internationally.

In Chapter 5, I performed three simulations which take labor outflow, remittances resulted, labor inflow and capital mobility into account.

Chapter 5

A CGE ANALYSIS OF STRATEGIC ECONOMIC POLICIES ON WAGE RATES, CAPITAL PRICE AND LAND PRICE IN NORTH CYPRUS

Different economic policy strategies have many implications over the supply and demand sides of economies in general. Factor mobility especially in labour market and resulted external income in North Cyprus has recently set a good example for us to study their implications on economic well-being.

In the case of small North Cyprus economy, although there are limitations on international trade, production factors such as labor and capital are mobile. In the North, some group of unskilled workers besides the newly graduated work force who cannot find job based on their skills or would not work at ongoing wage rate move daily to the South to benefit from the employment opportunities in the South Cyprus labor market. On the other hand, North Cyprus labor market attracts workers mainly from Turkey and thus, out-migrated workers are replaced by the Turkish workers. Therefore, North Cyprus economy is not only affected by out-migration, but also the economy is influenced by the inflow of foreign workers.

In this chapter I performed three simulations to investigate the impacts of different economic policy strategies on economic well-being and on allocation of wealth in

North Cyprus. In all three scenarios, (national) income is increased by 12.5 million TL, due to temporary migrant remittances. First scenario which is implemented suggests that supply of unskilled labour is reduced by 10 percent due to out-migration. Here I keep other factors of production fixed and let wages, rent and price of capital to adjust. Second scenario is based on an impact of external factor income in the form of remittances allowing a labor inflow to the North to replace those who work in the South. At this scenario unskilled labor supply which was reduced in the first scenario, is replaced by the foreign (Turkish) workers and thus unskilled labor supply remains unchanged compare to the benchmark year. Besides the labor mobility, capital inflow to the country is provided by letting capital initiative free keeping capital price rigid at an initial value. At the third and final simulation, in addition to the external income (remittances) and free capital flow, labor mobility is restricted to keep the wages at the initial equilibrium level. This policy simulation suggests that, labor supply should be increased by only 6.80 percent in order to keep the wages at their competitive level.

Tables 5 to 8 present the outcome of all three simulations on main macro-economic indicators, savings and income, factor prices, factor supplies and output. Under the first scenario, we observed that with 10 percent reduction in supply of unskilled labor and transferred remittances by an estimated 12.5 million TL, increased wages of unskilled labor by 9.32 percent and accelerated the expenditures on final demand. Despite the positive impact over the final demand, GDP decreased from 228,769,259 million TL to 227,008,838 million TL due to a rise in imports. Relative prices of domestic to imported goods increased and thus, imports increased by 9.63 percent. However, investments which are jointly financed by domestic savings and foreign

savings increased by 4.82 percent. Remittances in North Cyprus positively and significantly affect the performance of the economy over the demand side but even with an external income flow, supply side deteriorates due to income loss resulted from labor-outflow and higher relative prices. Overall effect of the first simulation was discussed in Chapter 4.

Table 5. Counterfactual Equilibrium Compared to Benchmark Equilibrium on Main Macro-Economic Indicators

	Benchmark	Simulation 1	Simulation 2	Simulation 3
Investment	49,779,827	51,192,385	52,918,234	52,781,296
Inventories	3,075,951	3,160,341	3,215,586	3,246,179
Consumption	188,419,094	196,020,741	201,543,501	205,054,509
Public Expenditures	62,884,655	65,785,620	67,007,250	67,816,438
Imports	163,766,671	179,537,497	183,678,341	186,146,556
Import Duty	23,527,821	24,787,814	25,344,619	25,706,912
Exports	111,904,224	115,175,063	119,315,899	121,784,094
GDP	228,769,259	227,008,838	234,977,509	238,829,048
Output	377,115,512	371,440,999	385,493,701	393,833,973

Source: Author's creation from GAMS output for the North Cyprus Economy

In Table 6 percentage changes in final demand, GDP and output are presented for all three simulations.

Table 6. Change in Main-Macro-Economic Variables

	Simulation 1 % Change	Simulation 2 % Change	Simulation 3 % Change
Investment	2.84	6.30	6.03
Inventories	2.74	4.54	5.53
Consumption	4.03	6.97	8.83
Public Expenditures	4.61	6.56	7.84
Imports	9.63	12.16	13.67
Import duties	5.36	7.72	9.26
Exports	2.92	6.62	8.83
GDP	-0.77	2.71	4.40

Source: Author's creation from GAMS output for the North Cyprus Economy

In simulation 2, out-migrated Turkish Cypriot workers are replaced by the foreign workers therefore there is no change in the unskilled labor supply. Only impact over the main-macroeconomic variables is caused by the remittances in this scenario. GDP increases from 228,769,259 million TL to 234,977,509 million TL as a result of the rise in final demand. Besides the improvement of the demand side, supply side improved and thus output increased from 377,115,512 million TL to 385,493,701 million TL. As shown in Table 8, change in the unskilled labor supply compared to the benchmark year is 0.00 percent but as compare to the first simulation, unskilled labor supply is increased by 10 percent. Therefore findings reveal that, at this scenario, out-migrated Turkish Cypriot workers are replaced by the foreign workers,

and together with the remittance effect, wages of unskilled labor in North Cyprus increased by 5.62 percent. Prior to the second simulation, final demand increased, income and expenditures are accelerated and savings increased by 6.20 percent. With this scenario, I also relaxed the constraint on capital so that capital could freely inflow or outflow. Results show that, capital stock increased by 2.74 percent. Output, compare to the benchmark increased by 2.22 percent and thus supply side of the economy is also improved prior to the shock.

Table 7. Percentage Change of Savings, Income and Factor Prices

	Simulation 1	Simulation 2	Simulation 3
	% Change	% Change	% Change
Savings	4.82	6.20	6.00
Private Saving	12.61	15.15	16.88
Foreign Saving	0.00	0.00	0.00
Public Saving	0.00	0.00	0.00
Tax Revenue	5.78	8.21	9.82
Income	7.13	9.67	11.39
Expenditure	6.46	9.00	10.73
Unskilled labor wage	9.32	5.62	0.00
Skilled labor wage	3.57	6.39	8.27
Price of Capital	1.42	0.00	0.00
Rent	2.45	5.85	8.00
CPI	2.37	1.93	1.76

Source: Author's creation from GAMS output for the North Cyprus Economy

Final simulation is to suggest a policy strategy on a current stage of the economy that labor outflow is replaced by the foreigners and there is still an inflow of external income in terms of remittances in North Cyprus. In this scenario, inflow of unskilled labor to North Cyprus is controlled, in other words restricted so that labor market remains in equilibrium. It is observed that when supply of foreign workers is controlled, only 6.80 percent foreign workers of the initial domestic unskilled labor supply bring the labor market back to the initial equilibrium level and thus resulted impact on the unskilled wages is decreased. Compared to the benchmark equilibrium, percentage change in unskilled labor wage is zero percent. Results are presented in Table 8.

Table 8. Output and Factor Supplies Counterfactual Equilibrium Compared to Benchmark Equilibrium

	Simulation 1	Simulation 2	Simulation 3
	% Change	% Change	% Change
Output	-1.50	2.22	4.43
Unskilled labor Supply	-10.0	0.00	6.80
Skilled labor Supply	0.00	0.00	0.00
Capital Stock	0.00	2.74	4.63
Land & Resources	0.00	0.00	0.00

Source: Author's creation from GAMS output for the North Cyprus Economy

In North Cyprus, imports have been the major source of supplies of commodities demanded by institutions as well as by the producers demanding intermediate goods. And the dependency on imports is also revealed in this thesis. In the CGE model of North Cyprus, nominal exchange rate is kept fixed throughout all three simulations. It is observed that, in all cases final demand increased pushing the domestic prices up

and therefore domestic prices increased against the foreign prices. This led to a real exchange rate appreciation and thus, a real exchange rate appreciation stimulated imports as appreciation makes imported goods cheaper. However it should be noted that capital inflows by 2.74 percent and 4.63 percent respectively in the second and third scenario also influenced appreciation. As mentioned in the introduction chapter North Cyprus economy lacks the policy tools to control the foreign exchange market. Absence of the foreign exchange market intervention by the Central Bank prevents alleviation of exchange rates appreciation. GDP and Output increased by 4.40 percent and 4.43 percent respectively in the final scenario. This outcome suggests that not only the demand side but also the supply side of the North Cyprus economy is benefited from external income flow due to labor mobility to an extend that foreign labor inflow is kept under control.

Chapter 6

CONCLUSION

In this thesis, I constructed a static, single country CGE model for the North Cyprus economy to explore the implications of the labor mobility and remittances resulted on economic well-being in North Cyprus.

The CGE model has important and country-specific features that have not been applied in countries such that economy is isolated from the world economies and there are serious limitations on production as well as on international trade. Although North Cyprus economy suffers from lack of adequate fiscal and monetary policies, large public budget debt, high costs on fuel and manufacturing products and trade barriers with the rest of the world, some factors of production are tradable.

North Cyprus, as an outcome of a civil war was divided into two parts in 1974; the South and the North. The South part of the island is governed by the Greek Cypriots and the North is governed by the Turkish Cypriots. In 1983, Turkish Cypriots declared their independency but this has not been recognized by the rest of the world, except Turkey. North Cyprus therefore cannot trade freely but when it does it had to be through Turkey. However, Turkey has been the only main trade partner of North Cyprus since 1983 effectively. Besides that, North Cyprus uses Turkish Lira, supplied by the Central Bank of Republic of Turkey. Under these circumstances, the North Cyprus economy is highly vulnerable to the changes in economic circumstances in Turkey.

There had been many attempts to solve the conflict in Cyprus; attempts were either to recognise North Cyprus as an independent state or to re-unify the Island, proposed as an "Annan Plan". Unfortunately attempts to re-unite the island failed because of political dispute between Turkish and Greek Cypriot leaders and isolation from the world economy and unrecognized status of North Cyprus as a foreign state still continues.

In April 2003 borders between North and South Cyprus is eased and since then crossing the borders (Green Line) between the South and North Cyprus, became possible. Since then Turkish Cypriot workers started benefiting from the job opportunities in the South. North Cyprus economy not only experienced out-migration but also labor market conditions have changed due to large amount of immigrant workers coming from Turkey since 2004. In order to analyze the economy-wide and combined effects of out-migration, remittances resulted and immigration, a static, single country CGE model for the North Cyprus economy is built; where the CGE model is the first comprehensive model describing the economic activities in North Cyprus.

In this thesis, I performed three simulations to investigate the impacts of different economic policy strategies on economic well-being and on allocation of wealth in North Cyprus. In all three scenarios, (national) income is increased by 12.5 million TL, due to temporary migrant remittances. First scenario which is implemented suggests that supply of unskilled labour is reduced by 10 percent due to out-migration keeping other factors of production fixed. In the second scenario, Turkish Cypriot out-migrants are replaced by the foreign workers, letting capital initiative

free in order to analyse the remittance effect on economic well-being. At final simulation, in addition to the external income (remittances) and free capital flow, labor mobility is restricted to keep the wages in the initial equilibrium level.

Simulation results showed that under first scenario, external factor income and out-migration of unskilled workers induce increase in investments and savings which stimulates the demand side of the economy. In contrast due to a greater import demand, trade balance is deteriorated, real GDP decreased by 0.77 percent. When labor inflow is allowed, it is observed that there is a positive and significant influence on the demand side, as well as the supply side of the economy. GDP and output increase by 2.71 percent and 2.22 percent respectively.

Final simulation was to suggest a policy strategy on a current stage of the economy that unskilled labor is mobile internationally and there is an influence of an external income in terms of remittances in North Cyprus. In this scenario, the inflow of unskilled labor to North Cyprus is restricted to keep the wages in equilibrium. Simulation results show that only 6.80 percent foreign workers of the initial domestic unskilled labor supply bring the labor market back to the initial equilibrium level. However, capital is being mobile internationally and thus capital stock is increased by 4.63 percent in real terms. GDP and Output increased by 4.40 percent and 4.43 percent respectively and this outcome suggests that not only the demand side but also the supply side of the North Cyprus economy is benefited from external income flow due to labor mobility to an extend that foreign labor inflow is kept under control.

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APPENDICES

Appendix A. Tables of the Calibrated Parameters and Variables

TableA 1. Aggregated Social Accounting Matrix (SAM) of the North Cyprus Economy

	Factors of Production				Agents							
	Labor L	**Labor H**	**Land R**	**Capital K**	**Factors (1+2+3+4)**	**Industries (1-13)**	**Households**	**Saving-Investment**	**Government**	**Rest of World**	**Taxes**	**Total**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	29,740,138											
2		72,178,787										
3			4,575,385									
4				110,897,340								
5						228,769,256						***228,769,256***
6						148,346,249	188,419,094	52,855,776	62,884,655	111,904,224		***564,409,999***
7					217,391,650				10,999,555			***228,391,205***
8							24,650,610		-23,657,300	51,862,450		***52,855,760***
9											50,226,925	***50,226,925***
10						187,294,492						***187,294,492***
11					11,377,602		15,321,502			23,527,821		***50,226,925***
12					***228,769,252***	***564,409,997***	***228,391,206***	***52,855,776***	***50,226,910***	***187,294,495***	***50,226,925***	

Source: Author's creation

TableA 2. Shares of Savings, Investment and Trade Balance in Real GDP

	2000	**2004**	**2007**	**2010**
Total Investment	17.31	20.75	23.66	18.70
Fixed Investment	15.82	18.99	23.12	18.11
Public Investment	6.38	5.97	5.69	3.60
Private Investment	9.44	13.02	17.42	14.50
Total Savings	17.31	20.75	23.66	18.70
Foreign Savings	3.16	0.82	7.06	7.40
Domestic Savings	14.14	19.93	16.60	11.30
Public Revenues	37.38	41.65	37.78	37.54
Total Expenditure	51.12	52.03	46.15	47.40
Current Expenditure	19.87	17.98	20.25	20.31
Foreign Trade Balance	-4.15	-6.91	-9.64	-10.50

Source: State Planning Organization of North Cyprus

TableA 1. Calibrated domestic output, domestically supplied output and domestic sales of composite traded commodities and services

	XD_i	Share	XDD_i	Share	SX_i	Share
Sec 1	18,163,540	4.82	13,277,910	5.01	20,036,580	4.43
Sec 2	18,683,020	4.95	18,670,860	7.04	18,976,770	4.19
Sec 3	114,625	0.03	114,625	0.04	134,136	0.03
Sec 4	339,163	0.09	339,163	0.13	477,742	0.11
Sec 5	2,100,864	0.56	1,984,206	0.75	2,500,805	0.55
Sec 6	40,450,770	10.73	11,834,210	4.46	157,619,800	34.83
Sec 7	12,787,540	3.39	12,787,540	4.82	12,803,350	2.83
Sec 8	31,712,940	8.41	31,712,940	11.96	31,714,250	7.01
Sec 9	47,780,290	12.67	44,759,690	16.88	44,759,690	9.89
Sec 10	35,901,280	9.52	4,442,308	1.68	14,567,370	3.22
Sec 11	46,163,640	12.24	36,023,620	13.58	43,255,840	9.56
Sec 12	32,935,490	8.73	30,334,630	11.44	30,549,740	6.75
Sec 13	89,982,350	23.86	58,929,580	22.22	75,109,740	16.60
Total	377,115,512		265,211,282		452,505,813	

Source: Author's creation from GAMS output for the North Cyprus Economy

TableA 2. Calibrated Composite Values and prices for the 3-level CES production function

	J_i	G_i	j_i	g_i
Sec 1	7,503,738	7,263,867	1.0153	1.0584
Sec 2	9,835,623	9,759,920	0.9840	0.9933
Sec 3	78,425	76,121	1.1606	1.2056
Sec 4	208,231	193,880	1.1446	1.2596
Sec 5	796,860	706,207	1.4340	1.7120
Sec 6	7,032,455	5,943,650	1.6761	2.2946
Sec 7	1,636,563	2,294,150	2.0111	2.8528
Sec 8	9,202,945	8,465,943	1.3980	1.5689
Sec 9	9,665,005	8,351,027	2.1374	3.3992
Sec 10	9,050,373	7,612,247	1.6510	2.4623
Sec 11	10,777,430	8,999,222	1.7128	2.5885
Sec 12	14,644,510	11,691,910	1.1906	2.0395
Sec 13	14,946,160	30,466,330	2.0155	2.5349

Source: Author's creation from GAMS output for the North Cyprus Economy

TableA 3. Calibrated Scale Parameters for CES Production, CET Export Supply and CES Import Demand Functions

	A_i	αT_i	AR_i
Sec 1	2.6423	1.9416	1.9813
Sec 2	2.0334	1.2182	1.2685
Sec 3	1.6024	1.0023	1.7395
Sec 4	1.8605	1.0017	1.9365
Sec 5	3.1503	1.6733	1.8480
Sec 6	7.1639	1.9538	1.7495
Sec 7	5.8591	1.0007	1.0702
Sec 8	3.9770	1.0006	1.0128
Sec 9	6.0996	1.6946	1.0000
Sec 10	4.9683	1.8102	1.9208
Sec 11	5.4237	1.9096	1.7463
Sec 12	2.9792	1.732	1.1672
Sec 13	3.1081	1.9751	1.8222

Source: Author's creation from GAMS output for the North Cyprus Economy

TableA 4. Calibrated Distribution Parameters

	α_{I_i}	φT_i	γT_i	α_{c_i}	γ_i	β_i	δ_i
Sec 1	0.0000	0.4217	0.4378	0.0598	0.9729	0.9945	0.9884
Sec 2	0.0000	0.1193	0.1378	0.0448	0.9959	0.9992	0.9876
Sec 3	0.0000	0.2991	0.0017	0.0000	0.9766	0.9951	0.9864
Sec 4	0.0000	0.3945	0.0013	0.0002	0.9800	0.9837	0.9863
Sec 5	0.0000	0.3447	0.3299	0.0000	0.9036	0.9579	0.9859
Sec 6	0.3054	0.7928	0.5550	0.3729	0.7882	0.8806	0.9859
Sec 7	0.0000	0.0340	0.0005	0.0268	0.4102	0.4844	0.9850
Sec 8	0.5990	0.0064	0.0004	0.0000	0.9238	0.9777	0.9857
Sec 9	0.0677	0.0000	0.3376	0.1116	0.8550	0.7396	0.9793
Sec 10	0.0000	0.6015	0.6200	0.0469	0.8252	0.8127	0.9853
Sec 11	0.0106	0.3094	0.4214	0.1411	0.8542	0.8085	0.9839
Sec 12	0.0000	0.0777	0.3511	0.0398	0.9756	0.7497	0.9853
Sec 13	0.0173	0.3438	0.4600	0.0831	0.5159	0.3604	0.9854

Source: Author's creation from GAMS output for the North Cyprus Economy

TableA 5. Calibration of the indirect taxes

	tim_i	tk_i	tl_i	th_i	tr_i	tc_i
Sec 1	0.0444	-0.1204	-0.1204	-0.1204	-0.1204	0.0788
Sec 2	0.1202	-0.0491	-0.0491	-0.0491	-0.0491	0.0788
Sec 3	0.0699	0.0203	0.0203	0.0203	0.0203	0.0783
Sec 4	0.0392	0.0203	0.0203	0.0203	0.0203	0.0788
Sec 5	0.0632	0.0203	0.0203	0.0203	0.0203	0.0788
Sec 6	0.1890	-0.0145	-0.0145	-0.0145	-0.0145	0.0788
Sec 7	0.0000	0.0203	0.0203	0.0203	0.0203	0.0788
Sec 8	0.0000	0.0430	0.0430	0.0430	0.0430	0.0788
Sec 9	0.0100	0.3844	0.3844	0.3844	0.3844	0.0788
Sec 10	0.0000	0.0202	0.0202	0.0202	0.0202	0.0788
Sec 11	0.0000	0.1079	0.1079	0.1079	0.1079	0.0788
Sec 12	0.0000	0.0425	0.0425	0.0425	0.0425	0.0788
Sec 13	0.0000	0.0082	0.0082	0.0082	0.0082	0.0788

Source: Author's creation from GAMS output for the North Cyprus Economy

TableA 6. Percentage Change in Prices Prior to the Simulation 1

	Domestic Output Price % Change	Commodity Price % Change	Domestic Output Price Delivered to Home Market % Change
Sec 1	2.45	2.16	3.38
Sec 2	2.06	2.03	2.06
Sec 3	1.95	1.65	1.95
Sec 4	2.02	1.41	2.02
Sec 5	2.59	2.16	2.75
Sec 6	2.89	0.66	10.64
Sec 7	3.89	3.89	3.89
Sec 8	2.58	2.58	2.58
Sec 9	2.83	3.03	3.03
Sec 10	2.99	7.69	30.59
Sec 11	2.88	3.04	3.72
Sec 12	2.39	2.58	2.60
Sec 13	4.01	4.73	6.26

Source: Author's creation from GAMS output for the North Cyprus Economy

TableA 7. Percentage Change in Prices Prior to the Simulation 2

	Domestic Output Price % Change	Commodity Price % Change	Domestic Output Price Delivered to Home Market % Change
Sec 1	1.43	1.28	1.97
Sec 2	0.94	0.93	0.95
Sec 3	0.72	0.61	0.72
Sec 4	0.85	0.60	0.85
Sec 5	1.48	1.24	1.57
Sec 6	1.93	0.46	6.90
Sec 7	3.56	3.55	3.56
Sec 8	1.51	1.51	1.51
Sec 9	2.40	2.57	2.57
Sec 10	2.19	5.57	20.94
Sec 11	2.15	2.27	2.77
Sec 12	2.06	2.22	2.24
Sec 13	4.64	5.44	7.25

Source: Author's creation from GAMS output for the North Cyprus Economy

Table A10. Percentage Change in Prices Prior to the Simulation 3

	Domestic Output Price % Change	Commodity Price % Change	Domestic Output Price Delivered to Home Market % Change
Sec 1	1.17	1.05	1.61
Sec 2	0.81	0.80	0.81
Sec 3	0.57	0.49	0.57
Sec 4	0.70	0.49	0.70
Sec 5	1.07	0.90	1.14
Sec 6	1.47	0.36	5.20
Sec 7	3.01	3.00	3.01
Sec 8	1.15	1.15	1.15
Sec 9	2.35	2.51	2.51
Sec 10	1.80	4.56	16.71
Sec 11	1.86	1.97	2.39
Sec 12	2.31	2.49	2.51
Sec 13	4.69	5.51	7.35

Source: Author's creation from GAMS output for the North Cyprus Economy

Table A11. Change in Export and Import Prices Prior to all Simulations

	Import Price in World Prices	% Change	Export Price in World Prices	% Change
Sec 1	1.04	0.00	1.00	0.00
Sec 2	1.12	0.00	1.00	0.00
Sec 3	1.07	0.00	1.00	0.00
Sec 4	1.04	0.00	1.00	0.00
Sec 5	1.06	0.00	1.00	0.00
Sec 6	1.19	0.00	1.00	0.00
Sec 7	1.00	0.00	1.00	0.00
Sec 8	1.00	0.00	1.00	0.00
Sec 9	1.01	0.00	1.00	0.00
Sec 10	1.00	0.00	1.00	0.00
Sec 11	1.00	0.00	1.00	0.00
Sec 12	1.00	0.00	1.00	0.00
Sec 13	1.00	0.00	1.00	0.00

Source: Author's creation from GAMS output for the North Cyprus Economy

Appendix B. CGE Model for the North Cyprus Economy: GAMS

```
CGE Model for the North Cyprus Economy Using GAMS
* (TOTAL A Matrix)                                        December , 2012
* Declaration and Initial Values
*=============================================================

Sets
sec commodities /sec1, sec2, sec3, sec4, sec5, sec6, sec7, sec8,
                 sec9, sec10, sec11, sec12, sec13 /
;

Alias

   (sec, secc)          ;

Option decimals = 6      ;

Scalars

*---------Declaration of scalars & assignment of values ----------------------
        lwZ         initial price of unskilled labour          /  1  /
        hwZ         initial price of skilled labour            /  1  /
        kwZ         initial price of capital                   /  1  /
        rwZ         initial rental price of land               /  1  /
        LSZ         initial unskilled labor supply
        HSZ         initial skilled labor supply
```

KSZ initial capital stock

RSZ initial land supply

EXRZ initial exchange rate / 1 /

MYZ initial household income level (national income)

MZ initial consumer expenditure

REMITZ initial remmitances / 0 /

UZ Household's utility

PCINDEXZ initial consumer price index (commodities) / 1 /

TrfZ initial transfers to the households / 10999555 /

TRMZ initial income tax revenue (direct tax) / 470069 /

SHZ initial household savings

SZ initial total national savings

SFZ initial foreign savings

SGZ initial government savings / -23657284.99987890 /

CGTZ

EGZ initial government expenditures

tm tax rate on income

TAXRZ initial tax revenue on production and commodities

;

*---------- Declaration of parameters ----------

Parameters

A(sec) efficiency parameter in the nested CES production function where capital and unskilled labour are used as inputs

ge(sec) initial partial elasticity of substitution between composite input G and land R in the nested CES production function

/sec1 0.9, sec2 0.9, sec3 0.9, sec4 0.9, sec5 0.9, sec6 0.9, sec7 0.9, sec8 0.9, sec9 0.9, sec10 0.9, sec11 0.9, sec12 0.9, sec13 0.9 /

se(sec) initial partial elasticity of substitution between composite input J and skilled labour H in the nested CES production function

/sec1 0.9, sec2 0.9, sec3 0.9, sec4 0.9, sec5 0.9, sec6 0.9, sec7 0.9, sec8 0.9, sec9 0.9, sec10 0.9, sec11 0.9, sec12 0.9, sec13 0.9 /

e(sec) initial partial elasticity of substitution between capital K and unskilled labour L in the nested CES production function

/sec1 0.9, sec2 0.9, sec3 0.9, sec4 0.9, sec5 0.9, sec6 0.9, sec7 0.9, sec8 0.9, sec9 0.9, sec10 0.9, sec11 0.9, sec12 0.9, sec13 0.9 /

zeta(sec) initial distribution parameter for composite input G and land R in the nested CES production function

beta(sec) initial distribution parameter for composite input J and skilled labour H in the nested CES production function

gamma(sec) initial distribution parameter for capital and unskilled labour in the nested CES production function

alphaC(sec) Cobb douglas power for consumers

alphaI(sec) initial cobb-douglas power in Investment utility function

alphaG(sec) fixed coefficient for Government expenditures

alphaINV(sec) fixed coefficient of inventory change

phiT(sec) initial distribution parameter for Armington function

AR(sec) scale (efficiency) parameter of Armington function

zetaT(sec) initial elasticity of substitution of Armington function

/ sec1 6, sec2 4.8, sec3 6, sec4 6.444, sec5 4.05, sec6 4.051, sec7 5.5,
sec8 6, sec9 6, sec10 2, sec11 6, sec12 6, sec13 5.5 /
gammaT(sec) initial distribution parameter for CET function
alphaT(sec) initial scale (efficiency) parameter of CET function
sigmaT(sec) initial elasticity of transformation of CET function
/ sec1 2, sec2 2, sec3 2, sec4 2, sec5 2, sec6 2, sec7 2,
sec8 2, sec9 2, sec10 2, sec11 2, sec12 2, sec13 2 /
mps household's marginal propensity to save
adj(sec) adjustment parameter
io(sec,secc) input output (technical) coefficient
tl(sec) tax rate on unskilled labour wage
th(sec) tax rate on skilled labour wage
tk(sec) tax rate on capital return
tr(sec) tax rate on rent
tj(sec) tax rate on composite inputs K & L
tim(sec) import duty
tc(sec) tax rate on commodities
tcz(sec) initial tax rate on commodities (used for PCINDEX)
PZ(sec) initial price level of domestic output of the firm
/sec1 1, sec2 1, sec3 1, sec4 1, sec5 1, sec6 1, sec7 1, sec8 1, sec9 1,
sec10 1, sec11 1, sec12 1, sec13 1 /
PCZ(sec) initial price level of domestic sales of composite commodities
/sec1 1, sec2 1, sec3 1, sec4 1, sec5 1, sec6 1, sec7 1, sec8 1, sec9 1,
sec10 1, sec11 1, sec12 1, sec13 1 /
PDDZ(sec) initial price of domestic output delivered to home market

/sec1 1, sec2 1, sec3 1, sec4 1, sec5 1, sec6 1, sec7 1, sec8 1, sec9 1,

sec10 1, sec11 1, sec12 1, sec13 1 /

PWEZ(sec) initial world price of exports

/sec1 1, sec2 1, sec3 1, sec4 1, sec5 1, sec6 1, sec7 1, sec8 1, sec9 1,

sec10 1, sec11 1, sec12 1, sec13 1 /

PWIMZ(sec) initial world price of imports

/sec1 1, sec2 1, sec3 1, sec4 1, sec5 1, sec6 1, sec7 1, sec8 1, sec9 1,

sec10 1, sec11 1, sec12 1, sec13 1 /

PIMZ(sec) initial import prices in national currency

PEXZ(sec) initial export prices in national currency

SXZ(sec) initial domestic sales of composite commodities for both intermediate & final demanders

XDZ(sec) initial gross domestic output (production)

XDDZ(sec) initial domestic output which is supplied on domestic market

GZ(sec) initial composite input value for composite input value J and skilled labour H

JZ(sec) initial composite input value for unskilled labour and capital

LZ(sec) initial compensation to unskilled labour (unskilled labour demand)

HZ(sec) initial compensation to skilled labour (skilled labour demand)

KZ(sec) initial return to capital (capital demand)

RZ(sec) initial rent of the land (demand for land)

GPTZ(sec) initial price of composite input G (G = J + H)

JPTZ(sec) initial price of composite input J (J = K + L)

IZ(sec) initial investment demand for commodities (public & private)

DIZ

```
INVENTZ(sec)   initial change in inventories
INVZ
CZ(sec)        initial consumption expenditures
  CGZ(sec)     initial government demand for commodities ( exogenous
 government expenditures)
EXZ(sec)       initial export demand
IMZ(sec)       initial import demand
incomz(sec,secc)   initial intermediate commodity demand
TRLZ(sec)      initial tax revenue on unskilled labour use
TRHZ(sec)      initial tax revenue on skilled labour use
TRKZ(sec)      initial tax revenue on capital use
TRRZ(sec)      initial tax revenue on land use
TRIMZ(sec)     initial tax revenue on imports
TRCZ(sec)      initial tax revenue on commodities
;
Scalar
 rounding       rounding factor for data          / 8 /     ;

*------------------Data, initial values & calibration ----------------------
Table
 incomz(sec,secc)

      sec1         sec2         sec3         sec4         sec5         sec6         sec7         sec8
sec9      sec10     sec11         sec12      sec13
```

sec1 1789646 2605527 1305 1172284
1503206 14713 6562
sec2 218852 1198741 71 6605695
325583 2500
sec3 147 13 671 14574 1352
30114 30790
sec4
443345 7414
sec5 10113 333 588 5795 142242 2269
1883191 483 43344
sec6 4452637 3198872 9194 56908 625394 10973414
4547837 11465790 2620807 7508461 8934805 1483761 5215907
sec7 1796662 220618 1016 24250 550555
753973 22531 350824 1332340 172145 480455 388577
sec8 177 6627
61701 749353 4552 265706 31991
sec9 993259 870203 4041 11720 71744 2807084
432688 2568054 1775493 2914176 1532792 589664 1186895
sec10 1891 1473733 13554
63573 178462 108980 2500188 483134 188423
sec11 398442 331475 2514 17963 26635 1001850
182906 627909 964756 808692 5325517 1543946 1095100
sec12 386348 83701 80 93589 880332 139244
1007879 11385474 347923 3059882 2632820 1664325

sec13 301458 281083 2698 301 18580 916685
25939 508979 1246744 695107 789183 1102065 1309068

Table

dataz(*,sec)

sec1 sec2 sec3 sec4 sec5 sec6 sec7 sec8
sec9 sec10 sec11 sec12 sec13
LZ 331801 72296 2996 6829 131907 2805767 1873958
1181042 2513822 2904674 2819737 583046 14512263
HZ 79382 17296 735 5751 64969 1878034 3188702
399470 5583184 3726109 4364447 6149795 46720913
KZ 8329350 10105264 86212 226757 988049 9155284
1351713 11154352 12408748 11741476 13841983 16141663 15366488
RZ 156522 197654 1874 4986 24684 278246 133623
271301 583911 382680 476449 487079 1576377

TRKZ -1002633 -495728 1753 4611 20092 -132952 27487
479295 4769341 237311 1493355 685668 126355
TRLZ -39940 -3547 61 139 2682 -40745 38107
50749 966195 58707 304210 24767 119331
TRHZ -9555 -848 15 117 1321 -27273 64842
17165 2145914 75310 470862 261232 384175

TRRZ -18841 -9696 38 101 502 -4041 2717 11658
224428 7734 51402 20690 12962
TRCZ 958458 717999 50 2943 5974786 430045
1787302 751003 2260507 637513 1330827
TRIMZ 287055 32830 1274 5221 30718 23170418 0.0001
0.0000001 0.000001 0.00001 0.000001 0.00001 305

CZ 12159887 9109207 638 37342 0.00000001 75801686
5455952 0.00000001 22675371 9527920 28678892 8088085 16884114
CGZ 667329 25281 55836 0.000001 17517 5587599 266187
775807 1537412 1034536 492764 780058 51644329
IZ 0.000001 0.000001 0.000001 0.000001 0.000001 15200806
0.000001 29818332 3371657 0.00001 527752 0.000001 861280
INVENTZ 11077 -21426.948 -10358 368465 1166058
1325477 236659
EXZ 4885623 12162 0.000001 0.000001 116658 28616564
0.000001 0.000001 3020602 31458974 10140015 2600856 31052770
IMZ 6471608 273079 18237 133358 485881 122615154
15809 1308 0.0001 10125058 7232217 215105 16179857
;

* Reading data for calibration

LZ(sec) = dataz("LZ",sec) ;

HZ(sec) = dataz("HZ",sec) ;

KZ(sec) = dataz("KZ",sec) ;

RZ(sec) = dataz("RZ",sec) ;

```
TRKZ(sec) = dataz("TRKZ",sec) ;

TRLZ(sec) = dataz("TRLZ",sec) ;

TRHZ(sec) = dataz("TRHZ",sec) ;

TRRZ(sec) = dataz("TRRZ",sec) ;

CZ(sec)   = dataz("CZ",sec)  ;

CGZ(sec) = dataz("CGZ",sec);

IZ(sec)  = dataz("IZ",sec) ;

INVENTZ(sec)= dataz("INVENTZ",sec) ;

EXZ(sec) = dataz("EXZ",sec) ;

IMZ(sec) = dataz("IMZ",sec);

TRCZ(sec)  = dataz("TRCZ",sec)  ;

TRIMZ(sec) = dataz("TRIMZ",sec) ;
```

* Fixed factor endowmwnts

```
LSZ  = sum(sec, LZ(sec) )     ;

HSZ  = sum(sec, HZ(sec) )     ;

KSZ =  sum(sec,KZ(sec)  )     ;

RSZ = sum(sec,RZ(sec)   )     ;
```

* Calculating tax revenues   (Needed to balance the state budget)

```
TAXRZ   = sum(sec,  TRKZ(sec)   + TRLZ(sec) + TRHZ(sec) + TRRZ(sec)+
TRIMZ(sec) + TRCZ(sec)  ) + TRMZ   ;
```

* Calculating tax rates

```
tk(sec) = TRKZ(sec) / ( KZ(sec)*kwz )  ;

tl(sec) = TRLZ(sec) / ( LZ(sec)*lwz )   ;
```

```
      th(sec) = TRHZ(sec) / ( HZ(sec)*hwz )   ;

      tr(sec) = TRRZ(sec) / ( RZ(sec)*rwz )   ;

      tim(sec) = TRIMZ(sec) / ( IMZ(sec)  * PWIMZ(sec) *  EXRZ  )    ;

      tc(sec) = TRCZ(sec) / CZ(sec)       ;

      tcz(sec) = tc(sec)                  ;
* Domesticly inputed Output
     XDZ(sec) = round(sum(secc, incomz(secc,sec))  + LZ(sec) + HZ(sec) + KZ(sec)
              + RZ(sec)  +  (TRKZ(sec)  +  TRLZ(sec)  +  TRHZ(sec)  +  TRRZ(sec)),
rounding)   ;
* Technical coefficients
    io(sec,secc)    = incomz(sec,secc)   /  XDZ(secc)  ;



* Domestic output supplied on the domestic market  (domestically consumed output)
    XDDZ(sec) =  XDZ(sec) - EXZ(sec)  ;
* Supply of  output
    SXZ(sec)  =  XDDZ(sec)  + IMZ(sec) + TRIMZ(sec)     ;
* HHs Income = Factors income(net of direct taxes) + other income (transfers ) +
direct taxes
   MYZ =  (kwz* KSZ)  + (rwz * RSZ) + (lwz * LSZ) + (hwz * HSZ)  + TrfZ  ;
* Calculating income tax
    tm =  TRMZ  / MYZ  ;
* Calibrating the parameters for CES production function
    gamma(sec)=    1  /  (1+  ((  1+tl(sec))*lwz  )  /  ((1+tk(sec))*kwz)  *  (  KZ(sec)  /
LZ(sec) )**(-1/e(sec)) ) ;
```

JZ(sec) = (gamma(sec)*KZ(sec)**((e(sec)-1)/e(sec)) + (1-gamma(sec))*LZ(sec)**((e(sec)-1)/e(sec)))** (e(sec) /(e(sec)-1)) ;

JPTZ(sec) = ((gamma(sec)**e(sec)) * (((1+tk(sec))* kwz)**(1-e(sec))) + ((1-gamma(sec))**e(sec)) * (((1+tl(sec))*lwz)**(1-e(sec))))**(1/(1-e(sec))) ;

beta(sec)= 1 / (1+ (((1+th(sec))*hwz) /JPTZ(sec) * (JZ(sec) / HZ(sec))**(-1/se(sec)))) ;

GZ(sec) = (beta(sec)*JZ(sec)**((ge(sec)-1)/ge(sec)) + (1-beta(sec))*HZ(sec)**((ge(sec)-1)/ge(sec)))** (ge(sec) /(ge(sec)-1)) ;

GPTZ(sec) = ((beta(sec)**ge(sec)) * ((JPTZ(sec))**(1-ge(sec))) + ((1-beta(sec))**ge(sec)) * (((1+th(sec))*hwz)**(1-ge(sec))))**(1/(1-ge(sec))) ;

zeta(sec) = 1 / (1+ ((1+tr(sec))*rwz) / GPTZ(sec) * (GZ(sec) / RZ(sec))**(-1/ge(sec))) ;

A(sec) = XDZ(sec) / (zeta(sec) * GZ(sec)**((ge(sec)-1)/ge(sec)) + (1-zeta(sec))*RZ(sec)**((ge(sec)-1)/ge(sec)))**(ge(sec)/(ge(sec)-1)) ;

* Household"s Utility & Consumer expenditure (Budget of the Households)

```
      MZ = ( sum(sec, CZ(sec) * PCZ(sec) ) +  sum(sec, TRCZ(sec) ) )    ;

* Household Saving = Disposible Income - Expenditures  - Direct taxes

     SHZ = (  MYZ - MZ  - TRMZ )     ;

* Government Sector

      EGZ =   sum(sec, PCZ(sec) * CGZ(sec) ) + TrfZ ;

      CGTZ  =  sum(sec, PCZ(sec) * CGZ(sec) )  ;

      alphaG(sec) = CGZ(sec)  / CGTZ    ;
* Foreign Savings
      SFZ  =  sum(sec,  IMZ(sec)*PWIMZ(sec))  -  sum(sec,  PWEZ(sec)*EXZ(sec))  -
REMITZ    ;

* Total Saving = Household saving + public saving + foreign saving
      SZ = SHZ + (SGZ * PCINDEXZ)  + (SFZ * EXRZ) ;

* Households marginal propensity to save
     mps =  SHZ /  ( MYZ - TRMZ )   ;
     alphaC(sec) =   PCZ(sec) * CZ(sec) /  MZ     ;
     UZ = prod(sec,CZ(sec)**alphaC(sec))          ;
```

```
* Adjustment coefficient

        adj(sec) = ( SXZ(sec) - ( CZ(sec) + IZ(sec) + INVENTZ(sec) + CGZ(sec)  +
sum(secc, io(sec,secc)*XDZ(secc)) ) )  / XDZ(sec)    ;


* Calibrating parameters of the Bank's Utility Function (Cobb-Douglas)


         INVZ   = sum(sec,INVENTZ(sec) * PCZ(sec) )  ;


         DIZ  =  sum(sec,IZ(sec)*PCZ(sec) ) + INVZ   ;


         alphaINV(sec)  = INVENTZ(sec)*PCZ(sec)  /  SZ          ;


         alphaI(sec) = IZ(sec) *PCZ(sec) / (SZ - INVZ)   ;
* Calibrating Import and Export Prices
        PIMZ(sec)  = (1+ tim(sec)) * PWIMZ(sec) * EXRZ   ;
        PEXZ(sec) =  PWEZ(sec) * EXRZ                  ;


* Calibrating the parameters of Armington Function  ( Demand side )
       phiT(sec) = 1/ ( 1+ (PDDZ(sec) / PIMZ(sec) ) * ( IMZ(sec) / XDDZ(sec) )**(-
1/zetaT(sec)) )      ;
       AR(sec) =  SXZ(sec) / ( PhiT(sec)* IMZ(sec)**
                          ( (zetaT(sec)-1) /zetaT(sec) ) +
                          (1- phiT(sec))* XDDZ(sec)**
                          ( (zetaT(sec)-1) / zetaT(sec) ) )**
                          (zetaT(sec) / (zetaT(sec) -1) )                              ;
```

```
* Calibrating the parameters of CET Function  ( Supply side )
        gammaT(sec) = 1/ ( 1+ (PDDZ(sec) / PEXZ(sec) ) * ( EXZ(sec) / XDDZ(sec)
)**(-1/sigmaT(sec)) )    ;
        alphaT(sec) =  XDZ(sec) / ( gammaT(sec)* EXZ(sec)**
                        ( (sigmaT(sec)-1) /sigmaT(sec) ) +
                        (1- gammaT(sec))* XDDZ(sec)**
                        ( (sigmaT(sec)-1) / sigmaT(sec) ) )**
                        (sigmaT(sec) / (sigmaT(sec) -1) )                    ;
*========Declaration of model variables ============================
Variables
        lw        price of unskilled labour
        hw        price of skilled labour
        kw        price of capital
        rw        rent of land
        JPT(sec)  composite price for capital and unskilled labor
        GPT(sec)  composite price for upper nest CES production function
        PC(sec)    prices of commodities demanded
        P(sec)      price level of domestic output  (firm)
        PDD(sec)   price of domestic output delivered to home market
        PEX(sec)   export prices in national currency
        PIM(sec)   import prices in national currency
        EXR        exchange rate
        PCINDEX   consumer price index (commodities)
        SX(sec)   domestic sales of composite commodities
```

XD(sec) output

XDD(sec) domestic output which is supplied on domestic market

EX(sec) exports

IM(sec) imports

C(sec) consumption

I(sec) investment demand for commodities (public & private)

DI

CG(sec) government demand for commodities (government expenditures)

INVENT(sec) inventories

INV total inventories

G(sec) composite input of J and H

J(sec) composite input which consist of unskilled labour and capital

L(sec) unskilled labour demand

K(sec) capital demand

H(sec) skilled labour demand

R(sec) demand for land

LS Unskilled labor supply

HS Skilled labor supply

KS Composite supply of capital

RS Supply of land and resources

MY households income (national)

M composite goods consumer expenditure (budget constraint)

REMIT remittances

SH household savings

S national savings

SF foreign savings

SG government savings

EG government expenditure

CGT total government consumption

TAXR tax revenue (indirect)

Trf total transfers to the households

TRICK artificial objective variable

;

Positive Variables

lw, hw, kw, rw, P, XD, L, H, K, R, LS, HS, KS, RS, C, G, J, JPT, GPT, EG, CGT

PC, PDD, PEX, PIM, EXR, PCINDEX, SX, XDD, EX, IM, I, DI, CG, MY, M, Trf,

INV, REMIT

;

Equations

*==========Households (Cobb Douglas.==========

EQC(sec) Demand equation commodities

EQSH Households saving

*========== Firms production ==========

EQL(sec) unskilled labour demand function of the firm(sec)

EQK(sec) Capital demand function of the firm

EQJ(sec) composite input function for unskilled labour and capital

EQH(sec) skilled labour demand function of the firm(sec)

EQG(sec) composite input function for composite J and H

EQR(sec) Land demand function of the firm

EQPROFIT(sec) zero profit condition for the firm)

*========== Government==========

EQCG(sec) Government consumption

EQGREV Government total revenue (from taxes and other sources)

EQGOVEXP Government Expenditures on goods and transfers

EQGOVBAL Government balance (balanced budget)

*========== Investment ==========

* EQSF Foreign savings

EQS National savings (total)

EQINV Total inventories

EQINVENT(sec) inventories by sector

EQDI Total investment plus inventories (GFCF)

EQI(sec) Investment demand function for commodities

*========== Trade Closure ==========

EQEXPORT(sec) Export Supply

EQXDD(sec) Domestic supply of domestic commodities

EQPROFITCET(sec) Zero profit condition of CET

EQIMPORT(sec) Import Demand

EQIMPARM(sec) Demand for domestic goods

EQPROFITARM(sec) Zero profit condition for Armington

*================== Market Clearing Equations ================

EQMARKETL market clearance for unskilled labor

* EQMARKETK market clearance for capital

EQMARKETH market clearance for skilled labor

EQMARKETR market clearance for land

EQMARKETXD(sec) market clearance for all commodities (Supply = Demand)

EQTRADEBAL BOP

*============ Other Definitions of the Market =========

EQJPT(sec) Composite price for J

EQGPT(sec) Composite price for G

EQEXPPRICE(sec) Export price equation

EQIMPPRICE(sec) Import price equation

EQPCINDEX Laspeyres price index

EQINCOME Households national income

EQDISINCOME Households expenditure on commodities

*================== Objective Function ===================

EQTRICK Artificial objective function ;

* =============== Specifying Model Equations =======

```
* FIRMS DEMAND SPECIFICATIONS  & ZERO PROFIT CONDITION

        EQK(sec)..K(sec) =E=   J(sec) * ( gamma(sec))**e(sec) * ((1+tk(sec))* kw
)**(-e(sec)) /
                        ( ( ( gamma(sec)**e(sec))* ((1+tk(sec))* kw)**(1-e(sec))
                        + ( (1-gamma(sec) )**e(sec))*( (1+tl(sec))*lw )**(1-e(sec))  )**
                         ( e(sec) /(e(sec)-1))  )                                    ;

        EQL(sec)..L(sec) =E=   J(sec) * ( (1-gamma(sec))**e(sec))*( (1+tl(sec)) *lw
)**(-e(sec)) /
                        (((  gamma(sec)**e(sec))*((1+tk(sec))* kw)**(1-e(sec))
                        + ( (1-gamma(sec) )**e(sec))*( (1+tl(sec))*lw )**(1-e(sec))  )**
                         (  e(sec) /(e(sec)-1))  )                                   ;

        EQJ(sec)..J(sec) =E=  G(sec)* (beta(sec))**se(sec)  *  ( JPT(sec))**(-se(sec)) /
                        ( (( beta(sec)**se(sec)) *( JPT(sec) )**(1-se(sec))
                          +( (1-beta(sec) )**se(sec)) * ( (1+th(sec))*hw )**(1-se(sec))  )**
                           ( se(sec) / (se(sec)-1)))                                 ;

        EQH(sec)..H(sec)    =E=         G(sec)*     ((1-beta(sec))**se(sec))        *        (
(1+th(sec))*hw)**(-se(sec)) /
                        ( (( beta(sec)**se(sec)) *( JPT(sec) )**(1-se(sec))
                          +( (1-beta(sec) )**se(sec)) * ( (1+th(sec))*hw )**(1-se(sec))  )**
                           ( se(sec) / (se(sec)-1)))                                 ;
```

```
EQG(sec)..G(sec) =E=    XD(sec) * (zeta(sec) )**ge(sec) * ( GPT(sec))**(-
e(sec)) /
                ( A(sec) *((  zeta(sec)**ge(sec))* ( GPT(sec) )**(1-e(sec))
                + ( (1-zeta(sec) )**ge(sec) )*( (1+tr(sec))*rw )**(1-ge(sec))  )**
                 ( ge(sec) /(ge(sec)-1))  )   ;

EQR(sec)..R(sec) =E=   XD(sec) * ( (1-zeta(sec)) )**ge(sec) * ( (1+tr(sec))*rw
)**(-e(sec)) /
                ( A(sec) *((  zeta(sec)**ge(sec))* ( GPT(sec) )**(1-e(sec))
                + ( (1-zeta(sec) )**ge(sec) )*( (1+tr(sec))*rw )**(1-ge(sec))  )**
                 ( ge(sec) /(ge(sec)-1))  )   ;

EQJPT(sec)..JPT(sec)  =E= (    (     gamma(sec)**e(sec))  *  (((1+tk(sec))*
kw)**(1-e(sec))  )  + ((1-gamma(sec))**e(sec)) * ( ((1+tl(sec))*lw )**(1-e(sec))) )**
( 1/(1-e(sec))  ) ;

EQGPT(sec)..GPT(sec) =E= (  ( beta(sec)**ge(sec)) *  ( JPT(sec)**(1-ge(sec))
)   + ((1-beta(sec))**ge(sec)) * ( ((1+th(sec))*hw )**(1-ge(sec))) )**( 1/(1-ge(sec)) )
;

EQPROFIT(sec)..P(sec)  *  XD(sec)   =E=     ((1+tl(sec))*lw*L(sec)  )   + (
(1+th(sec))*hw*H(sec)  )
                        + ((1+tk(sec))*kw*K(sec) )  + ((1+tr(sec))*rw*R(sec) )
                        + sum(secc, io(secc,sec)*XD(sec)*P(secc))     ;
* FIRMS INVESTMENT   (Constrained optimization)
```

```
*           EQSF..          SF =E=  sum(sec, IM(sec)*PWIMZ(sec)) - sum(sec,
PWEZ(sec)*EX(sec)) - EXR*REMIT    ;

        EQS..           S =E= SH  + (SG* PCINDEX) + (SF*EXR)          ;

        EQI(sec).. I(sec)*PC(sec) =E=  alphaI(sec)*( S - INV )      ;

        EQDI..   DI  =E=  sum(sec,I(sec)*PC(sec) ) +  INV ;

        EQINVENT(sec).. INVENT(sec)*PC(sec) =E=   alphaINV(sec) * S        ;

        EQINV..         INV =E= sum(sec, INVENT(sec) ) ;

*HOUSEHOLD'S DEMAND SPECIFICATION & ZERO PROFIT CONDITION

        EQC(sec).. PC(sec) * C(sec) =E= alphaC(sec)*  M     ;

        EQSH..   SH =E=   mps*( MY - (tm*MY )  )  + mps*REMIT        ;
* GOVERNMENT DEMAND, TAX & BUDGET BALANCE SPECIFICATIONS

        EQCG(sec)..       CG(sec) =E= alphaG(sec) * CGT         ;
        EQGREV..        TAXR  =E= sum(sec, (PC(sec)*tc(sec)* C(sec)
                                +       tl(sec)*L(sec)*lw       +tk(sec)*K(sec)*kw            +
th(sec)*H(sec)*hw
```

```
                    + tr(sec)*R(sec)*rw  +  tim(sec)*IM(sec)*PWIMZ(sec)  *
EXR )) + tm*MY     ;

      EQGOVEXP..      EG   =E= sum(sec,CG(sec) ) +  Trf ;
      EQGOVBAL..      TAXR     =E=  EG + SG       ;

* TRADE CLOSURE & BOP

      EQEXPORT(sec)..          EX(sec)   =E=      (XD(sec)   /   alphaT(sec))   *
(gammaT(sec)/PEX(sec))**sigmaT(sec)*
                                        ((gammaT(sec)**sigmaT(sec))*
                                        (PEX(sec)**(1-sigmaT(sec))) +
                                        ((1-gammaT(sec))**sigmaT(sec))*
                                        ( PDD(sec)**(1-sigmaT(sec))) )**
                                        (sigmaT(sec) / (1-sigmaT(sec)))     ;

      EQXDD(sec)..          XDD(sec)  =E=    (XD(sec)  /  alphaT(sec))      * ((1-
gammaT(sec))/PDD(sec))**sigmaT(sec)*
                                        ((gammaT(sec)**sigmaT(sec))*
                                        (PEX(sec)**(1-sigmaT(sec))) +
                                        ((1-gammaT(sec))**sigmaT(sec))*
                                        ( PDD(sec)**(1-sigmaT(sec))) )**
                                        (sigmaT(sec) / (1-sigmaT(sec)))     ;
```

```
EQIMPORT(sec).. IM(sec) =E= (SX(sec) / AR(sec)) *
(phiT(sec)/PIM(sec))**zetaT(sec)*
                                ((phiT(sec)**zetaT(sec))*
                                (PIM(sec)**(1-zetaT(sec))) +
                                ((1-phiT(sec))**zetaT(sec))*
                                ( PDD(sec)**(1-zetaT(sec))) )**
                                (zetaT(sec) / (1-zetaT(sec))) ;

EQIMPARM(sec).. XDD(sec) =E= (SX(sec) / AR(sec)) * ((1-
phiT(sec))/PDD(sec))**zetaT(sec)*
                                ((phiT(sec)**zetaT(sec))*
                                (PIM(sec)**(1-zetaT(sec))) +
                                ((1-phiT(sec))**zetaT(sec))*
                                ( PDD(sec)**(1-zetaT(sec))) )**
                                (zetaT(sec) / (1-zetaT(sec))) ;

* Zero Profit Condition for CET & ARMINGTON functions
EQPROFITCET(sec).. P(sec)*XD(sec) =E= PEX(sec)*EX(sec) +
PDD(sec)*XDD(sec) ;

EQPROFITARM(sec).. PC(sec)*SX(sec) =E= PIM(sec)*IM(sec) +
PDD(sec)*XDD(sec) ;

* MARKET CLEARING
EQMARKETL.. sum(sec, L(sec)) =E= LS ;
```

```
        EQMARKETH.. sum(sec, H(sec))  =E=  HS     ;
*         EQMARKETK..  sum(sec, K(sec)) =E=  KS     ;
        EQMARKETR..  sum(sec, R(sec)) =E=  RS     ;
        EQMARKETXD(sec)..  C(sec) + I(sec) +INVENT(sec) + CG(sec) + sum(secc,
io(sec,secc)*XD(secc))  =E= SX(sec) - (adj(sec)*XD(sec)) ;

        EQTRADEBAL..          sum(sec,  IM(sec)*PWIMZ(sec))  =E=  sum(sec,
PWEZ(sec)*EX(sec)) + SF + REMIT   ;

* OTHER DEFINITIONS

        EQEXPPRICE(sec)..   PEX(sec)   =E=  EXR *  PWEZ(sec)          ;

        EQIMPPRICE(sec)..   PIM(sec)   =E= (1+tim(sec))*EXR*PWIMZ(sec)  ;

        EQPCINDEX..         PCINDEX   =E=  sum(sec, (1+ tc(sec))*PC(sec)*CZ(sec))
/
                              sum(sec, (1+ tcz(sec))*PCZ(sec)*CZ(sec))    ;

        EQINCOME..          MY  =E=  (lw*LS) + (hw*HS) + kw*KS +  rw*RS  +  Trf
+ REMIT ;

        EQDISINCOME..       M  =E=   ( (1-tm)* MY  ) - SH    ;

*  ARTIFICIAL OBJECTIVE
```

```
EQTRICK..     TRICK =E=  1  ;
```

* MODEL DECLARATION IN NON-LINEAR PROGRAMMING (NLP) FORMAT =====

```
Model cgemodel /  All  / ;
```

```
* ======= Variable Initialization ============================
* Initial ( equilibrium) levels of endog. variables
        lw.L    = lwZ   ;
        hw.L    = hwZ   ;
        kw.L    = kwZ   ;
        rw.L    = rwZ   ;

        PC.L(sec)  = PCZ(sec)   ;
        P.L(sec)   = PZ(sec)    ;
        PDD.L(sec) = PDDZ(sec)  ;
        PEX.L(sec) = PEXZ(sec)  ;
        PIM.L(sec) = PIMZ(sec)  ;
        EXR.L      = EXRZ       ;
        REMIT.L    = REMITZ     ;
        PCINDEX.L  = PCINDEXZ   ;
        SX.L(sec)   = SXZ(sec)   ;
```

```
XD.L(sec)   = XDZ(sec)   ;

XDD.L(sec)  = XDDZ(sec)  ;

EX.L(sec)   = EXZ(sec)   ;

IM.L(sec)   = IMZ(sec)   ;

JPT.L(sec)  = JPTZ(sec)  ;

GPT.L(sec)  = GPTZ(sec)  ;

G.L(sec)    = GZ(sec)    ;

J.L(sec)    = JZ(sec)    ;

L.L(sec)    = LZ(sec)    ;

H.L(sec)    = HZ(sec)    ;

K.L(sec)    = KZ(sec)    ;

R.L(sec)    = RZ(sec)    ;

C.L(sec)    = CZ(sec)    ;

I.L(sec)    = IZ(sec)    ;

DI.L        = DIZ        ;

CG.L(sec)   = CGZ(sec)   ;

INVENT.L(sec) = INVENTZ(sec) ;

INV.L       = INVZ       ;

MY.L        = MYZ        ;

M.L         = MZ         ;

S.L         = SZ         ;

SH.L        = SHZ        ;

SF.L        = SFZ        ;

EG.L        = EGZ        ;

CGT.L       = CGTZ       ;
```

```
TAXR.L      = TAXRZ      ;

TRICK.L     = 1          ;


*  Including Lower Boundaries

* Lower boundaries to prevent numerical problems in optimization


lw.LO  = 0.000001*lwZ            ;

hw.LO  = 0.000001*hwZ            ;

kw.LO  = 0.000001*kwZ            ;

rw.LO  = 0.000001*rwZ            ;

JPT.LO(sec)  = 0.000001 * JPTZ(sec) ;

GPT.LO(sec)  = 0.000001 * GPTZ(sec) ;

G.LO(sec)   = 0.000001*GZ(sec)    ;

J.LO(sec)   = 0.000001*JZ(sec)    ;

PC.LO(sec)  = 0.000001*PCZ(sec)   ;

P.LO(sec)   = 0.000001*PZ(sec)    ;

PDD.LO(sec) = 0.000001* PDDZ(sec) ;

PEX.LO(sec) = 0.000001*PEXZ(sec)  ;

PIM.LO(sec) = 0.000001*PIMZ(sec)  ;

EXR.LO      = 0.000001*EXRZ       ;

REMIT.LO    = 0.000001*REMITZ     ;

PCINDEX.LO  = 0.000001*PCINDEXZ   ;

SX.LO(sec)   = 0.000001*SXZ(sec)   ;

XD.LO(sec)   = 0.000001*XDZ(sec)   ;

XDD.LO(sec)  = 0.000001*XDDZ(sec)  ;
```

```
EX.LO(sec)   = 0.000001*EXZ(sec)   ;

IM.LO(sec)   = 0.000001*IMZ(sec)   ;

L.LO(sec)    = 0.000001*LZ(sec)    ;

H.LO(sec)    = 0.000001*HZ(sec)    ;

K.LO(sec)    = 0.000001*KZ(sec)    ;

R.LO(sec)    = 0.000001*RZ(sec)    ;

C.LO(sec)    = 0.000001*CZ(sec)    ;

I.LO(sec)    = 0.000001*IZ(sec)    ;

DI.LO        = 0.000001*DIZ        ;

INV.LO       = 0.000001*INVZ       ;

CG.LO(sec)   = 0.000001*CGZ(sec)   ;

MY.LO        = 0.000001*MYZ        ;

M.LO         = 0.000001*MZ         ;

SF.LO        = 0.000001*SFZ        ;

SH.LO        = 0.000001*SHZ        ;

S.LO         = 0.000001*SZ         ;

EG.LO        = 0.000001*EGZ        ;

CGT.LO       = 0.000001*CGTZ       ;

TAXR.LO      = 0.000001*TAXRZ      ;
```

```
*========= Model Closure & Numeraire ============================
* Exogenously fixed variables
*      KS.FX = KSZ ;
*      LS.FX = LSZ ;
      RS.FX = RSZ ;
      HS.FX = HSZ ;
      SG.FX   = SGZ   ;
      EXR.FX  = EXRZ  ;
      Trf.FX  = TrfZ  ;
*      REMIT.FX = REMITZ ;
      SF.FX = SFZ  ;
 ;

* ==========POLICY SIMULATIONS - EXOGENOUS SHOCKS  =======

       REMIT.FX   = 12500000 * ( 1 + REMITZ)    ;
       LS.FX = 1.068 * LSZ       ;
*       HS.FX = 1.20 * HSZ       ;
*       RS.FX = 0.80 * RSZ       ;
*       KS.FX = 1.05 * KSZ       ;
*       lw.FX = lwz              ;
       kw.FX = kwZ              ;
cgemodel.holdfixed = 1           ;
cgemodel.TOLINFREP = .000001     ;
*option iterlim =  0     ;
```

```
option nlp  = pathnlp   ;

option limrow = 13  ;

option limcol = 13  ;

Solve cgemodel using NLP maximizing TRICK


Scalar U  ;

 U = prod(sec,C.L(sec)**alphaC(sec))   ;

$ontext

* =======    TESTS  ================================

* Check whether Walras Law Holds

Scalar walras  ;

 walras = sum(sec,L.L(sec)) + sum(sec,H.L(sec))+ UNEMPLL.L + UNEMPLH.L -

LS.L - HS.L ;

display walras ;

*  Homogeneity Test  (Doubling input prices had no effect on output)

 lw.FX  = 2 * lwZ  ;

 hw.FX  = 2 * hwZ  ;

 kw.FX  = 2 * kwZ  ;

display XD.L ;

$offtext

* ================ The End ===================================
```

Scalars

lw_index index of price of unskilled labour

hw_index index of price of skilled labour

kw_index index of price of capital

rw_index index of rental price of land

LS_index index of unskilled labour

HS_index index of skilled labour

KS_index index of capital

RS_index index of rental price of land

MY_index index of factor income(VA + others)

M_index index of consumer expenditure

S_index index of total savings

SH_index index of household savings

SF_index index of foreign savings

SG_index index of government savings

INV_index

DI_index

EXR_index index of exchange rate

TAXR_index index of tax revenues

Trf_index index of transfer payments

U_index index of HHs utility

;

```
lw_index      = 100 * (lw.L / lwZ-1)  ;

hw_index      = 100 * (hw.L / hwZ-1)  ;

kw_index      = 100 * (kw.L / kwZ-1)  ;

rw_index      = 100 * (rw.L / rwZ-1)  ;

LS_index      = 100 * (LS.L / LSZ-1)  ;

HS_index      = 100 * (HS.L / HSZ-1)  ;

KS_index      = 100 * (KS.L / KSZ-1)  ;

RS_index      = 100 * (RS.L / RSZ-1)  ;

MY_index      = 100 * (MY.L / MYZ-1)  ;

M_index       = 100 * (M.L / MZ-1)    ;

S_index       = 100 * (S.L / SZ-1)    ;

SH_index      = 100 * (SH.L / SHZ-1)    ;

SG_index      = 100 * (SG.L / SGZ-1)    ;

SF_index      = 100 * (SF.L / SFZ-1)    ;

INV_index     = 100 * (INV.L / INVZ-1)  ;

DI_index      = 100 * (DI.L / DIZ-1)    ;

EXR_index     = 100 * (EXR.L / EXRZ-1)  ;

TAXR_index    = 100 * (TAXR.L / TAXRZ-1) ;

Trf_index     = 100 * (Trf.L / TrfZ-1)  ;

U_index       = 100 * (U /UZ-1)         ;
```

Parameters

P_index(sec) domestic output price index

PC_index(sec) commodity price index

PDD_index(sec) price index of domestic output delivered to home market

XD_index(sec) index of gross domestic output (production)

G_index(sec) index of composite input value for composite input value J and skilled labour H

J_index(sec) index of composite input value for unskilled labour and capital

GPT_index(sec) index of composite prices of the upper nested production function

JPT_index(sec) index of composite prices of the lowest nested production function

L_index(sec) index of copmensation to unskilled labour (unskilled labour demand)

H_index(sec) index of compensation to skilled labour (skilled labour demand)

K_index(sec) index of return to capital (capital demand)

R_index(sec) index of rent of the land (demand for land)

C_index(sec) index of consumption of householdsd

I_index(sec) index of investment (GFCF) expenditures

INVENT_index(sec)

CG_index(sec) index of government expenditures

EX_index(sec) index of exports

IM_index(sec) index of imports

XDD_index(sec) index of domestic output which is supplied on domestic market

SX_index(sec) index of domestic sales of composite commodities for intermediate & final demanders

;

P_index(sec) = 100 * (P.L(sec) / PZ(sec)-1) ;

PC_index(sec) = 100 * (PC.L(sec) / PCZ(sec)-1) ;

PDD_index(sec) = 100 * (PDD.L(sec) / PDDZ(sec)-1) ;

XD_index(sec) = 100 * (XD.L(sec) / XDZ(sec)-1) ;

G_index(sec) = 100 * (G.L(sec) / GZ(sec)-1) ;

J_index(sec) = 100 * (J.L(sec) / JZ(sec)-1) ;

GPT_index(sec) = 100 * (GPT.L(sec) / GPTZ(sec)-1) ;

JPT_index(sec) = 100 * (JPT.L(sec) / JPTZ(sec)-1) ;

L_index(sec) = 100 * (L.L(sec) / LZ(sec)-1) ;

H_index(sec) = 100 * (H.L(sec) / HZ(sec)-1) ;

K_index(sec) = 100 * (K.L(sec) / KZ(sec)-1) ;

R_index(sec) = 100 * (R.L(sec) / RZ(sec)-1) ;

C_index(sec) = 100 * (C.L(sec) / CZ(sec)-1) ;

I_index(sec) = 100 * (I.L(sec) / IZ(sec)-1) ;

INVENT_index(sec) = 100 * (INVENT.L(sec) / INVENTZ(sec)-1) ;

CG_index(sec) = 100 * (CG.L(sec) / CGZ(sec)-1) ;

EX_index(sec) = 100 * (EX.L(sec) / EXZ(sec)-1) ;

IM_index(sec) = 100 * (IM.L(sec) / IMZ(sec)-1) ;

XDD_index(sec) = 100 * (XDD.L(sec) / XDDZ(sec)-1) ;

SX_index(sec) = 100 * (SX.L(sec) / SXZ(sec)-1) ;

Display

XD_index

XDD_index

SX_index

L_index

H_index

K_index

R_index

G_index

J_index

C_index

I_index

INVENT_index

CG_index

EX_index

IM_index

lw_index

hw_index

kw_index

rw_index

LS_index

HS_index

KS_index

RS_index

MY_index

```
        M_index
        Trf_index
        U_index
        S_index
        SH_index
        SF_index
        SG_index
        INV_index
        DI_index
        EXR_index
        TAXR_index
        P_index
        PC_index
        PDD_index
        GPT_index
        JPT_index
;
scalar walras ;

   walras = sum(sec,L.L(sec)) + sum(sec,H.L(sec)) - LS.L - HS.L    ;
```

Appendix C. Simulation Model Statistics

Report 1. Simulation 1 Software Output

GAMS Rev 233 WIN-VIS 23.3.3 x86/MS Windows 11/27/12

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE cgemodel Using NLP From line 902

MODEL STATISTICS

BLOCKS OF EQUATIONS	37	SINGLE EQUATIONS	301
BLOCKS OF VARIABLES	37	SINGLE VARIABLES	301
NON ZERO ELEMENTS	1,606	NON LINEAR N-Z	1,022
DERIVATIVE POOL	88	CONSTANT POOL	499
CODE LENGTH	11,112		

GENERATION TIME = 0.062 SECONDS 4 Mb WIN233-233 Dec 15, 2009

EXECUTION TIME = 0.078 SECONDS 4 Mb WIN233-233 Dec 15, 2009

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE cgemodel Using NLP From line 902

S O L V E S U M M A R Y

MODEL cgemodel OBJECTIVE TRICK

TYPE NLP DIRECTION MAXIMIZE

SOLVER PATHNLP FROM LINE 902

**** SOLVER STATUS 1 Normal Completion

**** MODEL STATUS 2 Locally Optimal

**** OBJECTIVE VALUE 1.0000

RESOURCE USAGE, LIMIT 0.187 1000.000

ITERATION COUNT, LIMIT 7 2000000000

EVALUATION ERRORS 0 0

PATH-NLP Nov 1, 2009 23.3.3 WIN 14594.15043 VIS x86/MS Windows

NLP size: 301 rows, 301 cols, 1606 non-zeros, 1.77% dense.

MCP size: 600 rows/cols, 4181 non-zeros, 1.16% dense.

**** REPORT SUMMARY :

0 NONOPT

0 INFEASIBLE

0 UNBOUNDED

0 ERRORS

USER: S101004:0441AN-WIN

Eastern Mediterranean University, Faculty of Business and EDC8623

License for teaching and research at degree granting institutions

**** FILE SUMMARY

Input C:\Users\NURU\Desktop\REMIT EFFECT\Remit_effect2a.gms

Output C:\Users\NURU\Documents\gamsdir\projdir\Remit_effect2a.lst

Report 2. Simulation 2 Software Output

GAMS Rev 233 WIN-VIS 23.3.3 x86/MS Windows 12/03/12

21:43:55 Page 5

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE cgemodel Using NLP From line 902

BLOCKS OF EQUATIONS	37	SINGLE EQUATIONS	301
BLOCKS OF VARIABLES	37	SINGLE VARIABLES	301
NON ZERO ELEMENTS	1,553	NON LINEAR N-Z	943
DERIVATIVE POOL	73	CONSTANT POOL	486
CODE LENGTH	10,189		

GENERATION TIME = 0.031 SECONDS 4 Mb WIN233-233 Dec 15, 2009

EXECUTION TIME = 0.031 SECONDS 4 Mb WIN233-233 Dec 15, 2009

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE cgemodel Using NLP From line 902

S O L V E S U M M A R Y

MODEL cgemodel OBJECTIVE TRICK

TYPE NLP DIRECTION MAXIMIZE

SOLVER PATHNLP FROM LINE 902

**** SOLVER STATUS 1 Normal Completion

**** MODEL STATUS 2 Locally Optimal

**** OBJECTIVE VALUE 1.0000

RESOURCE USAGE, LIMIT 0.064 1000.000

ITERATION COUNT, LIMIT 4 2000000000

EVALUATION ERRORS 0 0

PATH-NLP Nov 1, 2009 23.3.3 WIN 14594.15043 VIS x86/MS Windows

NLP size: 301 rows, 301 cols, 1553 non-zeros, 1.71% dense.

MCP size: 600 rows/cols, 4020 non-zeros, 1.12% dense.

S O L V E S U M M A R Y

PATH-NLP Nov 1, 2009 23.3.3 WIN 14594.15043 VIS x86/MS Windows

**** REPORT SUMMARY : 0 NONOPT

0 INFEASIBLE

0 UNBOUNDED

0 ERRORS

EXECUTION TIME = 0.015 SECONDS 3 Mb WIN233-233 Dec 15, 2009

USER: S101004:0441AN-WIN

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**** FILE SUMMARY

Input C:\Users\NURU\Desktop\REMIT EFFECT\Remit_effect2b.gms

Output C:\Users\NURU\Documents\gamsdir\projdir\Remit_effect2b.lst

Report 3. Simulation 3 Software Output

GAMS Rev 233 WIN-VIS 23.3.3 x86/MS Windows 12/03/12

21:53:05 Page 5

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE cgemodel Using NLP From line 905

MODEL STATISTICS

BLOCKS OF EQUATIONS	37	SINGLE EQUATIONS	301
BLOCKS OF VARIABLES	37	SINGLE VARIABLES	301
NON ZERO ELEMENTS	1,553	NON LINEAR N-Z	943
DERIVATIVE POOL	73	CONSTANT POOL	486

CODE LENGTH 10,189

GENERATION TIME = 0.031 SECONDS 4 Mb WIN233-233 Dec 15, 2009

EXECUTION TIME = 0.031 SECONDS 4 Mb WIN233-233 Dec 15, 2009

**** REPORT SUMMARY : 0 NONOPT

0 INFEASIBLE

0 UNBOUNDED

0 ERRORS

GAMS Rev 233 WIN-VIS 23.3.3 x86/MS Windows 12/03/12

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

E x e c u t i o n

USER: S101004:0441AN-WIN

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**** FILE SUMMARY

Input C:\Users\NURU\Desktop\REMIT EFFECT\Remit_effect2c.gms

Output C:\Users\NURU\Documents\gamsdir\projdir\Remit_effect2c.lst

GAMS Rev 233 WIN-VIS 23.3.3 x86/MS Windows 12/03/12

21:53:05 Page 6

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE cgemodel Using NLP From line 905

S O L V E S U M M A R Y

MODEL cgemodel OBJECTIVE TRICK

TYPE NLP DIRECTION MAXIMIZE

SOLVER PATHNLP FROM LINE 905

**** SOLVER STATUS 1 Normal Completion

**** MODEL STATUS 2 Locally Optimal

**** OBJECTIVE VALUE 1.0000

RESOURCE USAGE, LIMIT 0.052 1000.000

ITERATION COUNT, LIMIT 3 2000000000

EVALUATION ERRORS 0 0

PATH-NLP Nov 1, 2009 23.3.3 WIN 14594.15043 VIS x86/MS Windows