POVERTY EFFECTS OF
UKRAINE'S WTO ACCESSION

by

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ABSTRACT

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Poverty is one of the heaviest problems the Ukrainian society faces last decade. Accession into the WTO may be beneficial in terms of reducing poverty. In this paper I tried to analyze the impact the trade liberalization on households' income. A CGE microsimulation model was developed for Ukraine using recent (2002) micro- and macro level data. The simulation of 10% reduction in tariffs was conducted and new household income values were calculated using GAMS/MPSGE software. By calculating and comparing poverty measures before and after simulation, I found that import tariff reduction decreases the overall poverty. The conclusion of this work is that Ukraine's WTO accession is beneficial for Ukraine.

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GLOSSARY

CES Constant elasticity of substitution

CET Constant elasticity of transformation

CGE Computable general equilibrium (model)

Derzhkomstat State Statistics Committee of Ukraine

FGT denotes Foster-Greer-Thorbecke (poverty measure)

GDP Gross Domestic Product

IO Input-Output table that contains information about the market allocation of resources

SAM Social Accounting Matrix, an extended version of IO that contains information on interrelations between accounts

Chapter 1

INTRODUCTION

Ukraine initiated its accession into the WTO in 1996, when Ukrainian government adopted the convention "Of transformation of customs tariff of Ukraine for 1996-2005 according to GATT/WTO system"[1]. This convention required decrease of all import tariffs to the average level of maximum 14%. After the convention, a number of other documents were adopted, including the presidential decree "On Additional Measures for Speeding Up Ukraine's Entry into the World Trade Organization"[2]. The decree defined Ukraine's accession into the WTO as a foreign policy task of highest priority.

Poverty is an important characteristic of well-being of any society and the importance of poverty related researches is self-evident. However, the question of poverty in Ukraine is not sufficiently explored, despite the fact that since 1991 Ukraine has been facing a rapid growth of poverty and income inequality caused by economic crisis, hyperinflation and other phenomena of the transition period. In 1995, almost 32% of Ukrainians had less than $1 per day[3]; nowadays, this number is definitely higher, especially in rural areas.

Poverty has many dimensions and reasons. Individuals may be poor not only because of low income, though this is the most common and easiest to measure attribute of poverty. Often, poor people suffer from bad healthcare, discrimination, inefficient infrastructure etc. However, it would not be wrong to state that poverty in Ukraine has mostly monetary reasons – low absolute

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1 „Про Концепцію трансформації митного тарифу України на 1996-2005 роки відповідно до системи ГАТТ/СОТ" 06.04.1996 №255/96.

2 „Про додаткові заходи щодо прискорення вступу України до СОТ" №797/2001.

3 World Bank, 1996, Report 15602-UA: Poverty in Ukraine, (Washington: World Bank, June)

and real income caused mainly by unemployment and hyperinflation in early 90s. From this point of view, trade liberalization, which follows from the accession into the WTO, may have a great impact on poverty through income channel. One of the common arguments for trade liberalization is that it may raise wages thus helping to reduce poverty in a country.

The purpose of this paper is to examine how the coming trade liberalization may affect well-being of Ukrainian households. In particular, I calculate the impact of import tariff elimination on household income.

The paper is organized a follows. Chapter 2 provides a short discussion on how trade may influence poverty and general description of methods used to explore this question. Chapter 3 is a description of poverty situation in Ukraine. Chapter 4 presents a simple CGE model as well as some methodology issues. Chapter 5 is devoted to data description and reconciliation. In Chapter 6 I describe a CGE microsimulation model and discuss the findings.

Chapter 2

THEORETICAL BACKGROUND

1. The linkage between trade and poverty.

Trade shocks definitely influence poverty, though there are no theoretical discourses that could determine, neatly and unambiguously, the direction and magnitude of this influence. Empirical findings on this matter are full of controversy. For example, Taylor and Vos (2000) have studied growth, inequality and poverty patterns in a series of Latin American countries after trade liberalization in 80s-90s and have found a variety of results. This may be partially explained by the fact that some countries launched different policies and adjustment programs along with trade liberalization during this period, and influence of trade policy on growth, inequality and poverty is indistinguishable from influences of other policies. However, the counterfactual CGE analysis, conducted by Ganuza et al. (2001) has showed controversy as well. McCulloch et al. (2001) argued that the exact relationship between trade policy and poverty can hardly be determined empirically, as a researcher should not only separate off the trade policy effects but also find appropriate trade openness and poverty measures – a nontrivial, if not impossible, task. Instead, we should consider possible channels through which trade shocks may influence poverty.

Winters (2000) defines the following potential links between trade policy and poverty:

a) changes in prices and availability of goods;

b) changes in factor income and employment of resources;

c) changes in government revenues with possible changes in taxes and transfers;

d) changes in risks, adjustment costs and prospects for long-run growth.

The most obvious way the trade reform influence a household's welfare is through changes in prices of goods[4]. Deaton (1997) shows that the effect of a price changes on a household's welfare can be expressed as:

$$\frac{\partial u}{\partial \ln p_i} = \frac{\partial \psi}{\partial \ln x} \cdot \frac{p_i(y_i - q_i)}{x},$$

Where $u = \psi(p, income)$ - indirect utility function, x is a household's consumption level, q_i is consumption of good *i,* and y_i is production of good i. The term $\frac{\partial \psi}{\partial \ln x}$ is a proportional marginal utility of money that is assumed to be positive. Thus, households benefit from a price rise of some good if they are net producers of this good. And as long as we consider households as net consumers rather then 'farm households', we may state that a price rise hurts households welfare. However, two points must be taken into account. First is that final effect of price change may depend on initial institutional pattern. If, for example, government initially protects small farmers with import tariffs, trade liberalization may turn them in poverty. Second point is that if trade policy change and particularly, trade liberalization usually involve many goods; thus, the net effect on household utility may be quite difficult to predict.

Another potential link between trade and poverty is through factor income and employment. The Stolper-Samuelson theorem is the main theoretical motivation of this linkage. The logical chain is simple: trade shocks influence prices and, hence, incentives for firms to produce or not to produce particular goods. According to the Heckscher-Ohlin theorem, a country has a comparative advantage in the good which production requires intensively

4 The burden of poverty within a household may be unequal. This issue is very hard to explore and generalize, and I consider it unimportant in the context of this study. Thus, I regard a household as a 'fundamental bearer of poverty'.

the relatively abundant factor of the country. If trade liberalization increases the relative price of this good then, by the Stolper-Samuelson theorem, the relative real return on the relatively abundant factor increases. In the context of the poverty alleviation, the theorem theoretically should work as follows. With the trade liberalization in labor-abundant country, prices of the labor-intensive goods rise, therefore firms have more incentive to produce more. Factors of production are drawn from other sectors, relatively more capital-intensive. The labor-intensive sector uses more labor per unit of capital; therefore additional labor must be employed. This increases both employment of labor and its relative price to capital. Both sectors can switch to less labor intensive technologies, which increases the marginal product of labor, which, in turn, increases real wage. This reasoning predicts that the trade liberalization should theoretically fight poverty and income inequality. The countries that suffer from poverty usually have relatively large supplies of unskilled labor, i.e. are unskilled-labor-abundant. Thus, free trade should raise wages of unskilled workers and reduce poverty and inequality.

Despite all its elegance, the Stolper-Samuelson theorem has a limited use in terms of predicting poverty impacts of trade liberalization. Winters (2000) argues that the theorem rests on a set of quite restrictive assumptions, violation of which may erode its power and definitiveness. In fact, many empirical studies show results opposite to the theorem's predictions. Davis (1996) gives a simple theoretical explanation for this controversy. He states that though a country may be labor-abundant in the global sense, it does not automatically means that its labor force will benefit from trade liberalization. It is more important in what factors is the country abundant within its "cone of diversification" – a set of countries that have similar factor endowments and produce the same range of goods. A labor-abundant country in the global economy may be capital-abundant in its cone; therefore wages in such country may fall after the trade liberalization.

Tariff reduction may also reduce government revenues and decrease its ability to support poor households with transfers. Summarizing, one may state that the links between trade and poverty are very complex and case-specific. It is impossible to predict definitely the poverty impact of trade liberalization without any prior analysis.

2. Literature review.

McCulloch et al. (2001) identify three main types of approaches to explore the linkage between trade and poverty, namely, descriptive, data-based and modeling approaches.

Descriptive approaches gather and analyze information about a particular trade policy, reforms that were undertaken and all changes in the welfare caused by the reforms. Though this approach may provide a deep understanding of the particular trade reform and its influence on poverty and income distribution, it is not based on any theoretical model. For that reason all the results of descriptive studies can not be generalized and used outside the studied case.

Data-based (or empirical) approaches are usually grounded on a particular theory about the linkage between trade policy and poverty and collect data to test this theory. Therefore, unlike the previous approaches, data-based approaches can test the underlying hypothesis statistically. If this testing is based on the sample data, the obtained results may be generalized to the population level. The obvious limitation of data-based approaches is that not everything may be measured. Important qualitative factors may play a crucial role in explaining the linkage between poverty and trade policy. If they are not measured or measured improperly, the resulting statistical estimates could be biased.

Both descriptive and data-based approaches explain what already happened rather than what may happen, i.e. they are 'backward-looking'. In this sense they are inferior to modeling approaches. Modeling approaches build a theoretical model with explicitly stated links between trade reform and poverty and try to predict what effect on poverty a particular trade reform may have. Though a typical model is a theoretical construction, its parameters are often derived from real data. Moreover, models are often designed to reflect the empirical data for at least one point of time – i.e. they are calibrated. Modeling approaches provide a useful tool for 'forward-looking' and counterfactual trade policy analysis. There is, however, a downside of this kind of approaches which follows from the nature of model construction. A model is based on a set of beliefs about how main economic agents and indicators interact. These beliefs may not fully reflect the real economy and may cause serious errors in results.

All of the studies that refer to modeling approaches may be classified into three groups according to methodology engaged: partial-equilibrium analysis, cross-country regressions and general-equilibrium simulations.

Studies within partial-equilibrium framework focus mainly on poverty issues at the individual or household level, thus limiting themselves to a small number of markets in the economy. An example of partial-equilibrium analysis is Deaton (1989) who engages a non-parametric analysis to examine how higher rice prices might affect the welfare of Thai households. As the majority of partial-equilibrium studies, this research uses data from a household survey (Socioeconomic Survey of the Whole Kingdom of Thailand) and concludes that higher prices for rice would benefit all rural households, though the rural middle-income ones would be the greatest winners from a hypothesized increase in price for rice. In general, the main advantage of partial-equilibrium framework is that it allows a very detailed analysis of a limited number of markets. The drawback is that the trade liberalization usually affects many, if not all, markets in the economy and the resulting effect on household welfare may be quite complex; partial-equilibrium analysis is not able to take into account this complexity. In addition, it is difficult to explore a factor income link between trade and poverty within this framework (except for labor income) because household surveys usually report earnings less detailed than expenditures.

The next group of modeling approaches – cross-country regressions – uses quite straightforward methodology: it tries to find a correlation between poverty indices and trade openness indicators from different countries. The example is Santarelli and Figini (2002). The authors used, among others, indices of trade and financial openness as well as absolute and relative poverty measures, and tried to find relationship between them with econometric tools. They found no clear-cut relationship between poverty and, in particular, trade openness and conclude that more specific and country-oriented approaches must be engaged. It is common shortcoming of cross-country regressions that they do not account for a country's specification. Another shortcoming is that, as was noted above, both poverty and trade openness is not easily measured. The positive side of the method is its simplicity.

General equilibrium framework is widely used for analysis of trade and poverty issues since late 70s. All papers that use this framework may be classified into three categories: the computable general equilibrium models with representative agents (representative household approach), the CGE microsimulation models and micro-macro simulation models.

The first attempt to use computable general equilibrium framework (CGE) for analysis of poverty and distribution issues was made by Adelman and Robinson (1978) in Korea. The authors have built a CGE of South Korea model with 15 representative households, including skilled and unskilled workers in different industries, capitalists, agricultural workers etc. The distribution of income for each household type was modeled as a 2-parameter lognormal distribution function. This study is a typical representative of the representative household approach. The main idea of this approach is to build a CGE with several aggregate households, each representing a particular socioeconomic group of population (i.e. rural and urban, rich and poor etc.). The CGE model is used to evaluate the impact of a particular trade policy on income of each representative household, i.e. on income distribution of the defined groups of population. However, nothing can be said about the distribution of income within each group. It is often argued in the literature, that intra group inequality may contribute more to overall inequality than inter group inequality. The traditional RH approach is also little in terms of poverty analysis. In order to circumvent these limitations, the CGE simulation is often amended with household survey analysis. The researchers specify the functional distribution of income (usually as the lognormal distribution function) for each household group, based on actual survey data and introduce a poverty line. The typical example of this approach is Decaluwe, Patry and Savard (1998). The authors built a CGE model for archetypal African country with six population groups. They define the income distribution function for each group as the Beta distribution function (for the real data, the income distribution function is presumed to be estimated from a household survey) and assume that income distribution within each group is constant. Decaluwe et al. argue that the beta distribution is preferable to other distribution functions, as it can be skewed to left or right representing the actual intra group distribution. As a mean income of each group changes, the income distribution shifts by the proportional variation. The authors also specify an endogenous poverty line represented by the value of an exogenous basket of goods. The poverty line increases if prices of the goods in the basket, following an external shock, rise. Movement of the poverty line together with distribution function allows a more detailed analysis of the poverty impact of a particular policy. However, this amended RH approach rests on the assumption that all parameters in the distribution function (except for mean income) are fixed and not affected by the policy shock.

Thus, the main problem with the RH approach is that it does not consider intra group information. The logical extension of the RH approach, the microsimulation approach[5], eliminates this limitation by increasing the number of households in the CGE model to the number of households in a household survey. Each household from the survey is modeled separately in the CGE model. The examples of this approach are Cockburn (2001) and

[5] Savard (2003) makes reference to this approach as the multi-household approach to distinguish it from other studies that use microsimulation modeling.

Cogneau and Robillard (2000). The structure of the CGE microsimulation studies is simple. An income and consumption vector of a representative household in a Social Accounting Matrix is replaced with household income and consumption vectors from a household budget survey (the vectors must be adjusted to macro level data first). Then, the CGE model is constructed for this extended SAM; policy simulations generate a new set of income and consumption vectors, which can be compared to the existing set. The CGE microsimulation approach has a considerable advantage over the RH approach in terms of both poverty and distribution analysis, as it allows to consider intra group income distribution This approach was applied, for example, by Cockburn (2001) for Nepal and Decaluwe, Dumont and Savard (1999) for archetypal economy. Decaluwe et al. (1999) developed two models using fictitious data: the aggregated CGE model with three household groups, the amended CGE model and the CGE microsimulation model. They conducted import tariff reduction simulation for each model and concluded that the CGE microsimulation analysis has a greater explanatory power not only in terms of income distribution analysis – which is appreciated, but also in question of poverty analysis.

The serious limitation of both the RH-CGE approach and the CGE microsimulation approach is that they, due to their macroeconomic nature, allow no flexibility in modeling of household behavior. In other words, the CGE models do not consider such issues as labor-leisure choice, gender issues etc.

The third approach, the micro-macro simulation, provides a greater flexibility in modeling households and labor markets, while keeps all the benefits of macromodeling. The idea behind this method is to build a microsimulation model as well as the CGE model[6]. The CGE model is used for macrosimulation to obtain some macro variables to be used in microsimulation. The example of this approach is Bourguignon, Robilliard

[6] In fact, any type of macro model may be used; however, all distinct studies in this field use the CGE model for macro simulation.

and Robinson (2003). The authors build a household income generation model along with the CGE model for Indonesia. Both models are initially built consistent to each other, variables –average earnings, the number of occupied, etc.- which appear in both models are equalized. The CGE model generates a new vector of macro variables that is put into micro model; the latter is then recomputed to be consistent with the newly obtained macro variables. Thus, there is a one-directional link between two models: from macro to micro level. Savard (2003) argues that this does not guarantee the coherence between the macro and micro models. In his experimental paper he proposes the CGE-household sequential model that, by introducing a bi-directional link between the macro and micro models, accounts the feedback effect of household behavior in the CGE model. The shock variables generated in the CGE are put into the household model, which results are put back into the CGE model. This process is repeated until the convergence between the models is reached, according to several controlling variables.

The macro-micro approach allows a richer specification of household behavior comparing to the thraditional CGE-RH models. Its main drawback, behind its complexity and difficulties to implement, is that the coherence between macro and micro models is not guaranteed and a convergence solution, as in Savard (2003), can not be always reached.

Chapter 3

POVERTY IN UKRAINE

The communist ideology did not admit any existence of poor people in the FSU, except for short post-war period, though they definitely existed. Consequently, no estimation of the standards of living was conducted and now it is impossible to compare situation in contemporary Ukraine with the Ukrainian Soviet Socialistic Republic. But without any doubts, the poverty in Ukraine has increased since 1991. Professor Revenko defines the following evidences of growing poverty in independent Ukraine:

- The reduction of GDP per capita with following decrease of the final consumption of households
- Increased income inequality: the Soviet Ukraine has the 'decile ratio' (ratio of the income of the richest 10% to the income of the poorest 10%) of 3.88 compared to 5.66 for the FSU; since 1991 to 1997 the 'decile ratio' deteriorated to 13.8.
- The decrease of income caused changes in the structure of household expenditures: the share of food expenditures has increased but the structure of nutrition has worsened. Non-food expenditures has fallen as well s their shares.
- Many households, including urban ones, get involved in agricultural production.
- The residential construction has decreased (up to 2/3 of all housing in the FSU was given free of charge); provision of healthcare, education, recreation (subsidized sanatoria, children camps etc.) and public transport has fallen.
- The average total income (money and natural) of the rural population has come close to that of urban population. Cash income in cities is usually higher, but this is overweighed by higher natural income. This phenomenon has two negative consequences: first, it makes poverty

monitoring more difficult, and second, it raises problems for the elaboration of anti-poverty programs.

- The registered and unregistered unemployment increased (there was no official unemployment in the FSU).
- New phenomenon - wage arrears - has appeared.
- Millions of Ukrainians have lost their savings in banks and trust funds after the collapse of the FSU. Additionally, the hyperinflation in the early 90s badly hurt the poorest strata.
- The birth rate has fallen while the death rate has increased.

Despite its obvious significance, poverty in Ukraine is not intensively discussed and analyzed. Two analyses of Ukrainian situation are available: The World Bank's Poverty Assessment of Ukraine and the report made by Professor Revenko (Institute of Economic Forecasting, Ukrainian Academy of Sciences). Both reports are dated by 1996 and their estimations are definitely out of date. Here I tried to make my own calculations of poverty indices using data from the Derzcomstat household budget survey for 2002 and calculated the FGT poverty measures using DAD utility[7].

The Foster-Greer-Thorbecke (FGT) poverty measures (named after their inventors, Foster, Greer, Thorbecke (1984)) provide an aggregate estimate of poverty for a country or a region. They base on measures of the welfare of households or individuals. As a measure of welfare, values of income or consumption are usually used; however, any other welfare measure can be used as long as its increase indicates increase in welfare. In general, the FGT poverty index is as follows:

$$P(k;z;\alpha) = \frac{1}{\sum_{i=1}^{n} sw_i^k} \sum_{i=1}^{n} sw_i^k (z - y_i)_+^\alpha \quad (1)$$

[7] DAD is free software designed to conduct analysis of social welfare, poverty, inequality and equity across distributions of living standards. Authors: Jean-Yves Duclos, Abdelkrim Araar, Carl Fortin

where z is a poverty line, α is a parameter, y_i is a variable of interest, k and i are group and observation indices respectively; sw_i^k is a product of a sample weight of observation i and a size of observation i (e.g. number of individuals in a household). The value of parameter α can be chosen: with $\alpha = 0$, the formula (1) becomes a simple headcount ratio, i.e. the proportion of population or population group below the poverty line (z).
Poverty depth can be measured with a poverty gap (α is set to 1). The severity of poverty is measured with $\alpha = 2$. In general, the higher the parameter α the more importance is given to the poorest.
Table 1 shows the calculated FGT poverty measures.

Table 1. FGT poverty measures (normalized).

Type of household	FGT poverty measure ($\overline{P}_\alpha$)		
	$\alpha = 0$	$\alpha = 1$	$\alpha = 2$
Urban (cities)	0.505	0.152	0.067
Urban (towns)	0.685	0.244	0.119
Rural	0.755	0.296	0.154
Total	0.650	0.233	0.115

These measures are individual-adjusted, and show how poverty is distributed across individuals rather than across households. Absolute poverty line is 2000 UAH per year, which is approximately $1 per day. These indices are normalized as follows:

$$\overline{P}(k;z;\alpha) = \frac{P(k;z;\alpha)}{(z)^\alpha}.$$

The headcount ratio for the whole population is 0.65, which means that 65% of Ukrainian population has a daily income less that $1. Rural population suffers more from poverty than population in small and large towns. This is consistent with both Professor Revenko's report and the report of the World Bank. They state that an average rural household has less cash income than an average urban household. In the same time rural households obtain larger in-kind income from agricultural activity. Table 2 shows some average income and expenditures characteristics of the three types of population.

Table 2. Average income and expenditures

Household type	Income, UAH		Expenditures, UAH		Share of food	
	Total	Cash	Total	Food	Expenditures	Cash income
Urban (cities)	7308	6721	7558	4633	0.64	0.80
Urban (towns)	6545	5489	5699	3660	0.66	0.79
Rural	7023	5036	4239	2633	0.63	0.60

Obviously, urban households, both from towns and cities, are better off in terms of cash income and total expenditures. In the same time, rural households tend to spend less of their cash on food as they have more in-kind income.

Chapter 4

METHODOLOGY

1. The computable general equilibrium model.

Computable general equilibrium models are macroeconomic models that can be applied to a wide range of economic issues, such as trade, tax or other policy. In particular, they are widely used for policy simulations and counterfactual analysis.

The model described here is the simplest example of a computable general equilibrium model[8]. It has 2 goods, 2 factors of production and 1 'representative household' and uses Cobb-Douglas functions for both production and utility. Household income is denoted by Y, consumption quantities - by C_1, C_2, and unit factor inputs are k_1, l_1, k_2, l_2. The economy is assumed to be closed and perfectly competitive, with constant return to scale. Under these conditions the long-run profits are zero (according to Euler's Theorem) and no supply function for any production sector can be defined.

Let the production function are:

$$X_1 = K_1^{1/4} L_1^{3/4}$$

$$X_2 = K_2^{1/2} L_2^{1/2},$$

and household utility function is:

$$U = C_1^{1/2} C_2^{1/2},$$

then we may derive the following:

Commodity markets

[8] "Applied General Equilibrium Modeling" 2000, lecture notes, http://www.nottingham.ac.uk/~lezgr/teaching/CGE/lectures_1&2.htm (based on Dinwiddy and Teal (1988)).

Demand

$$C_1 = \frac{Y}{2p_1} \qquad (1)$$

$$C = \frac{Y}{2p_2} \qquad (2)$$

Unit price equations

$$p_1 = rk_1 + wl_1 \qquad (3)$$

$$p_2 = rk_2 + wl_2 \qquad (4)$$

Market cleaning

$$C_1 = X_1 \qquad (5)$$

$$C_2 = X_2 \qquad (6)$$

<u>Factor markets</u>

Demand

$$k_1 = \left(\frac{1}{3}\frac{w}{r}\right)^{\frac{3}{4}} \qquad (7)$$

$$K_1 = k_1 X_1 \qquad (8)$$

$$l_1 = \left(3\frac{r}{w}\right)^{\frac{1}{4}} \qquad (9)$$

$$L_1 = l_1 X_1 \qquad (10)$$

$$k_2 = \left(\frac{w}{r}\right)^{\frac{1}{2}} \qquad (11)$$

$$K_2 = k_2 X_2 \qquad (12)$$

$$l_2 = \left(\frac{r}{w}\right)^{\frac{1}{2}} \qquad (13)$$

$$L_2 = l_2 X_2 \qquad (14)$$

Market cleaning

$$K_1 + K_2 = K^* \qquad (15)$$

$$L_1 + L_2 = L^* \qquad (16)$$

Household income

$$Y = rK^* + wL^* \qquad (17).$$

There are 17 endogenous variables:

$P_1, P_2, w, r, C_1, C_2, X_1, X_2, k_1, k_2, K_1, K_2, l_1, l_2, L_1, L_2, Y$.

These 17 equations are not independent (Walras' Law), therefore one variable must be chosen as a numeraire. Dinwiddy and Teal offer the following solution to the problem for $K^* =$ 0.8 and $L^* = 0.2$ when the wage rate is chosen as a numeraire:

$P_1 = 1.95, \quad P_2 = 2.46,$

$r = 1.52, \; w = 1,$

$C_1 = X_1 = 0.82, \quad C_2 = X_2 = 0.65,$

$K_1 = 0.26,\ K_2 = 0.53,$

$L = 1.2,\ L_2 = 0.8.$

To construct a similar model that reflects ‘real’ economy, the data from national accounts. Usually, it is hard to obtain data on factor payments and good prices, in particular because industries in CGE models of real economy are often aggregated. It is easier to find data value terms – output, payments to factors, household income etc. This kind of data is usually contained in input-output tables.

An input-output table contains the information about the market allocation of resources and the flows among different sectors in an economy. This data is commonly used for building static computable general equilibrium models or can serve as a benchmark for dynamic models.

Table 3. Structure of input-output table

	Intermediate use	Final use	Output
Domestic production	A	B	C
Imports	D	E	F
Value added	G	H	I
Input	J		

An IO table represents the value of transactions in an economy and shows the cost structure of production activities. Table 1 illustrates a general structure of an IO table. The matrix A represents the intermediate demand: the quantities of goods and services demanded by production sectors. Rows of the matrix A describe production sector outputs. Columns describe sectors that use outputs of production as intermediate inputs. Matrix B shows a final demand, which is usually divided among private sector consumption, government or public sector consumption, investment and exports. Matrix C is a total domestic production. Matrix D, E, F shows the corresponding information on imported goods and services. Payments to factors of production, depreciation and indirect taxes are shown in matrix G. Matrix H is usually empty in an IO table. Matrix I gives information on value added. An IO table should be balanced, i.e. columns of matrix J should be equal to rows of matrix C, because total input must equal output for production sectors.

Values of transactions are measured in one of three ways: in basic prices, producers' prices or in consumers' prices. The basic prices equal the sum of costs of the goods and services used in production and of payments to factors of production. Producers' prices equal to the basic price plus net taxes on the products by the producer. Consumers' price is the total price paid by consumer: producers' price plus trade and transport margins.

Without modifications, a typical IO table is not appropriate for the general economic modeling, as it lack data on distribution of income. In traditional economic modeling, data is presented in the form of a Social Accounting Matrix (SAM). In terms of the table 1, the matrix H is present. In particular, for production and consumption decisions, behavior is captured by non-linear first-order optimality conditions. The system also must satisfy a set of constraints, such as balance for savings and investments, balance of payments etc. A usual basis for a SAM is an IO table, though other data –from national accounts, household surveys etc.- is often used to construct a SAM.

A structure of a CGE model is follows from the structure of the SAM: the model explains all the transaction described in underlying SAM. In particular, the modeler specifies his assumptions about agents' behavior: chooses production functions for producers and utility functions for consumers. All data in a SAM is in value terms. The absolute prices are unknown and not important, because, as it was shown in the example above, one variable must be chosen as a numeraire, and in the most cases this is one of prices. The model is, therefore, is solved in relative prices. It is quite common that modelers follow so called *Harberger Convention* – all prices are set to unity in the 'benchmark' equilibrium, so the values in the SAM become the quantities.

Thus, the first and the second stages of building a CGE model are constructing a SAM and defining the mathematical specification of the model respectively. The next step is to find parameters that are consistent with the initial data – the process called *calibration*.

The production and utility functions in the model described above may be written in general as:

$$X_1 = AK_1^{\alpha} L_1^{1-\alpha}$$

$$X_2 = BK_2^{\beta} L_2^{1-\beta}$$

$$U = X_1^{\theta} X_2^{1-\theta}.$$

The goal of calibration process here is to find $A, B, \alpha, \beta, \theta$ that are consistent with the SAM. For a perfect competition, the rice of each factor is equal to the value of its marginal product. For sector 1:

$$r = p_1 \frac{\partial (AK_1^{\alpha} L_1^{1-\alpha})}{\partial K_1} = p_1 \alpha A K_1^{\alpha-1} L_1^{1-\alpha} = p_1 \alpha \frac{X_1}{K_1}$$

and

$$\alpha = \frac{rK}{P_1 X_1}.$$

The value of payments to capital is known as well as the value of good 1 produced, consequently α can be calculated. Similarly one can calculate the parameter β. To calibrate A and B, we should assume that prices are equal to 1, and values in the SAM become quantities. For A:

$$A = \frac{X_1}{K_1^{\alpha} L_1^{1-\alpha}}.$$

Similar relationship can be written for B.

This small model can be easily extended to introduce international trade – by introducing exports and imports. Let us denote the exported quantity of good 1 by E and the imported quantity of good 2 by M; p_1^w and p_2^w are the world prices of good 1 and good 2 respectively; F is an exchange rate. The world prices are exogenous and the exchange rate is endogenous.

The model is supplemented with the following equations:

Market clearing

$$C_1 = X_1 - E$$

$$C_2 = X_2 + M$$

Foreign sector equations and balance of payment

$$p_1 = p_1^w F$$

$$p_2 = p_2^w F$$

$$p_1^w E - p_2^w M = 0.$$

The 20 endogenous variables are:

$$p_1, p_2, w, r, C_1, C_2, X_1, X_2, k_1, k_2, K_1, K_2, l_1, l_2, L_1, L_2, Y, E, M, F\ .$$

The exogenous variables are:

$$K^*, L^*, p_1^w, p_2^w.$$

In this example, the production uses only two factors –labor and capital, however, in practice producers often use other goods –intermediates – to produce final goods. The use of intermediate goods is commonly modeled as a nested process that has, at least, 2 stages. The common assumption is that production uses intermediates in a constant proportion to the final output (i.e. Leontief), and that value is added to the intermediates by the use of factors of production. There is no substitution between intermediates and value-added by factors, but factors may be substituted for one another as in standard production function.

A basic trade (GE) theorem states that, with homogenous goods, the number of traded goods that a small open economy can produce is less that or equal to the number of distinct factors. This underlies the specification in many models that at least one factor is sector-specific, and that goods are differentiated by their country of origin (*the Armington Assumption*).The main reason for using the Armington Assumption is the presence of *cross-hauling* -the simultaneous exporting and importing of the same good. This can be accommodated by assuming that goods are differentiated or that there is an oligopolistic competition.

C h a p t e r 5

DATA DESCRIPTION

The Social Accounting Matrix (SAM) used in this study is built using data from the Ukrainian input-output table at consumer prices for 2002 and the Household Budget Survey, both produced by The Ukrainian State Statistics Committee (Derzcomstat). The IO table comprises information on relationships between 38 economic sectors, as well as on final consumption and structure of value added. The Household Budget Survey is a common household survey conducted by Derzcomstat on a yearly basis. It lists all consumption and non-consumption expenditures as well as all monetary and total incomes of 9,422 households. All principal groups of Ukrainian population are presented, but there are some shortcomings in the survey. Both rich and transfer-depended households are underrepresented, however, in the context of this work, this appears insignificant problem.

When linking macro and micro data, the problems of data reconciliation and adjustment arise. The first and most obvious one is that consumption and income items in the HBS do not match accounts in the IO table. To match each other, both IO sectors and HBS items were aggregated into 10 categories: therefore SAM has 10 sectors (and commodities), namely foodstuffs, energy sector, industry and trade sector, housing, healthcare, transport and communications, financial intermediation, recreation, education, other services. Table 2 presents IO and HBS consumption items grouping into SAM. The survey income breakdown includes 22 items. They were aggregated into 3 categories: labor income, capital income and transfers from public sector.

Table 3 presents the aggregated IO table. It includes only one household, which represents all households in the economy. For microsimulation task, the representative household must be replaced by all 9,422 households from the HBS. Obviously, they must be adjusted to be consistent with macro data by multiplying household consumption-income vectors by household sample weights. In other words, we construct 9,422 representative households from the HBS. Theoretically, the sum of their consumption and income should be equal to the IO household consumption-income. In practice, however, due to measurement and sampling errors as well as over- and underreporting both in surveys and input-output tables, these vectors are never equal each other. The following table presents consumption vectors from the IO table and the survey:

Table 4. Consumption vectors from the IO table and HBS, mln. UAH

SAM account	Survey consumption	IO consumption
FOOD	65.63	64.86
ENERGY	8.236	7.599
INDUSTRY	13.18	30.06
HOUSING	3.751	4.398
HEALTHCARE	3.899	1.751
COMMUNICATION	4.327	9.497
INTERMEDIATION	0.01165	0.012
EDUCATION	1.66	2.347
RECREATION	2.381	2.818
SERVICES	2.31	1.222

If we directly replace the IO table vector with the survey vector, the SAM becomes unbalanced. There are two methods to deal with this problem. The first is too put the survey vector into the SAM and to rebalance the matrix using appropriate technique, for example the cross-entropy method or the RAS technique. In our case this way may lead to severe distortion of the initial data and is inferior to the second method. The second method, proposed by Robillard and Robinson (1999), is to reweight households, i.e. to find a new positive vector of sample weights, which is close to the prior and satisfy known moment constraints.

Consider a sample of K households with prior survey probabilities $\overline{p}_k$ which results in income-consumption vectors $\overline{x}_k$. In addition, there is some information about weighted averages of some household information. The task is to minimize the cross-entropy measure:

$$Min\sum_k p_k \ln\left(\frac{p_k}{\overline{p}_k}\right)$$

Subject to consistency and normalization constraint:

$$\sum p_k f(x_k) = y$$
$$\sum p_k = 1$$

where y is a set of data that must be consistent with estimated probabilities, and $f(\bullet)$ is an aggregator of household variables. The implicit assumption here is that all data except sample weight is measured precisely.

In our case, the problem may be restated as follows. We have matrix X which has 9,422 columns. Column k is a consumption-income vector of kth household (k=1...9,422). We also have vector of prior sample weights $\vec{w}$; each element w_k of $\vec{w}$ is a number of households in real economy represented by kth household in the sample. From the IO table we know vector $\vec{y}$ - an aggregation of household information. The task is to find a new vector of weights $\vec{w}'$ consistent with y by minimizing the cross entropy measure:

$$Min\sum_k w'_k \ln\frac{w'_k}{w_k},$$

Subject to:

$$\vec{w}'_k \cdot X = \vec{y}$$
$$\sum_k w'_k = \sum_k w_k .$$

This is a typical optimization problem with non-linear objective function and linear constraints; it was solved using GAMS software. The obtained vector of weights $\vec{w}'$ was used to adjust household data to macro level.

Chapter 6

EMPIRICAL WORK

1. CGE microsimulation model.

The model described here is a standard static general equilibrium model, similar to one in Rutherford and Paltsev (1999). It has 10 sectors and commodities, two factors of production, 9422 households, government, investment and foreign trade (exports and imports) sectors. The relationship between different blocks in the model is shown in Figure 1.

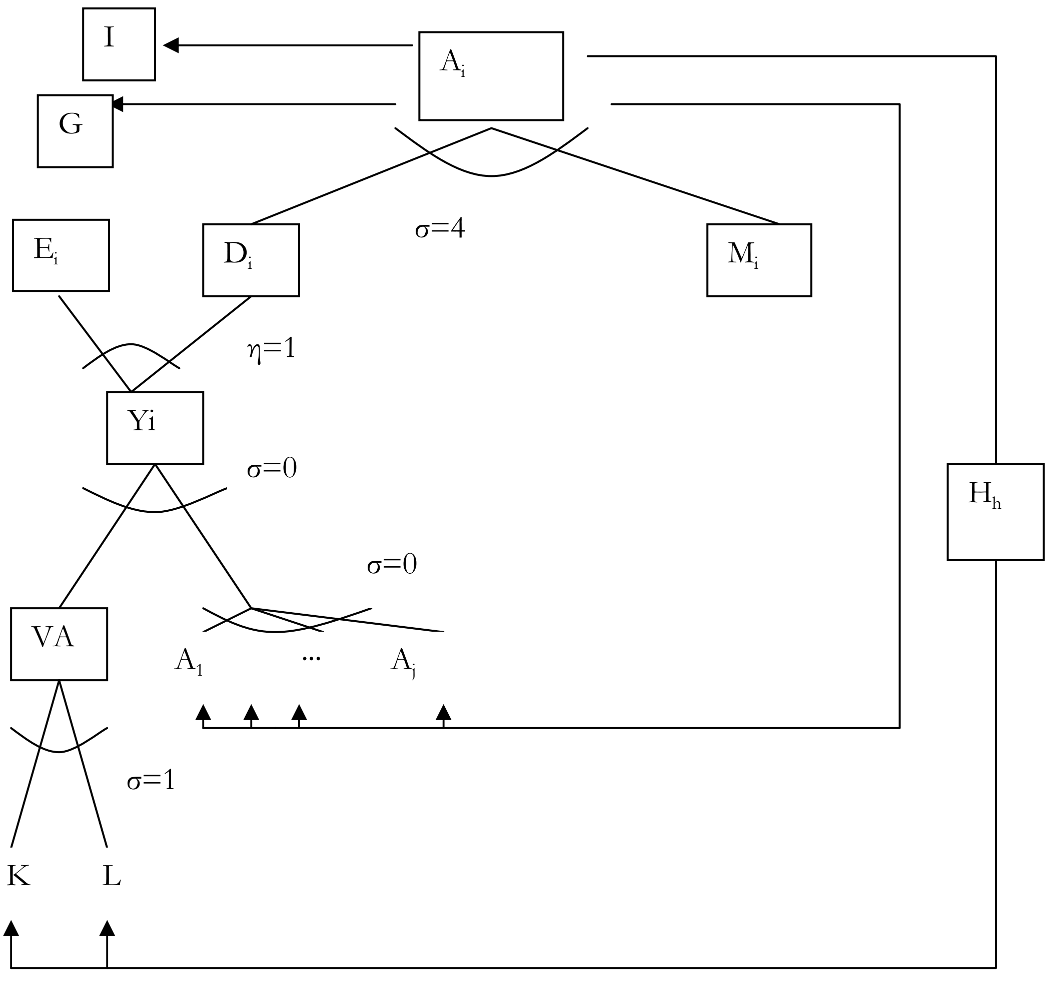

Figure 1. Structure of the model

The model has the following structure.

Production (Y_i) is modeled as a Leontief function between the value-added (VA) and the intermediates (Armington aggregates) (A_{ij}). The value-added is created using two factors of production – labor and capital, assuming Cobb-Douglas production function. The process of production is, therefore, has 2-stage nested structure:

$$Y_i = LF\lfloor CD(K_i, L_i), LF(A_{i1}, A_{i2}, ..., A_{ij})\rfloor$$

Output Y_i is divided between domestic consumption (D_i) and exports (E_i) according to a constant elasticity of transformation function with the elasticity of transformation of 1 (Cobb-Douglas):

$$Y_i = CET(D_i, E_i).$$

Armington aggregate A_i is a composite of the domestic goods D_i and the imported good M_i. We may think about Armington aggregation as a production process with inputs D_i and M_i and output A_i:

$$A_i = CES(D_i, M_i).$$

Households derive their income from selling their factors of production. They are assumed to maximize the utility, which is defined by a Cobb-Douglas function over 10 Armington aggregates.

$$U_h = CD(A_{ih})$$

Households also receive transfers from the government, which are held fixed in the model. Hence, there are 3 sources of income: labor and capital income and transfers. Some households in the survey report income lower then consumption i.e. have negative savings. This may cause problems in solution process and to avoid this I assume that in the current period households with negative savings use savings accumulated in the previous period.

Both government and investments demand Armington composites according to Leontief utility functions:

$$G = LF(A_i) \quad \text{and} \quad I = LF(A_i).$$

Government also pays transfers to households and collects taxes on output and import tariffs. Tax rates on output are defined from the IO table and are calculated for each sector as follows:

$$TaxRate = \frac{Taxes - Subsidies}{Output}.$$

As there is no information on import tariffs in the IO table, I applied an average tariff rate of 10% calculated by A. Korzhenevych[9].

2. Simulation results.

This model was solved using GAMS/MPSGE software. The trade liberalization implies reduction of import tariffs; consequently, I set import tariffs to 0 in the simulation. The reduction of import tariffs is therefore from 10% to 0 .

Tables 5, 6 and 7 show simulation results for three variables: output, exports and imports. There is a substantial increase in food sector output (33.8%); communication sector (18.36%) and recreation sector (13.45%). Total output increased slightly (0.74%). Exports show almost the same pattern: increase in food, communication and recreation sectors, but decrease in total value of

[9] A.Korzhenevych, How close to Europe is Ukraine: Trade Policy Analysis, EERC MA thesis.,2004

exports (4.42%). Except for housing and intermediation sectors, all imports increased, which is quite expected as relative price of imports increased.

Table 5. Simulation results: change in output

Sector	Output, mln UAH		Change	
	Reference (tariff=10%)	Simulation (tariff=0)	mln. UAH	%
Food	139562.00	186740.00	47178.00	33.80
Energy	48794.00	47299.20	-1494.80	-3.06
Industry	225451.00	197830.00	-27621.00	-12.25
Housing	34948.00	15374.03	-19573.97	-56.01
Healthcare	12096.00	12178.46	82.46	0.68
Communication	49940.00	59110.00	9170.00	18.36
Intermediation	9948.00	9141.95	-806.05	-8.10
Education	20305.00	18661.81	-1643.19	-8.09
Recreation	7167.00	8130.70	963.70	13.45
Other services	24380.00	22368.31	-2011.69	-8.25
Total	572591.00	576834.46	4243.46	0.74

Table 6. Simulation results: change in exports

Sector	Exports, mln UAH		Change	
	Reference (tariff=10%)	Simulation (tariff=0)	mln. UAH	%
Food	16379.00	20840	4461.00	27.24
Energy	2596.00	2439.2	-156.80	-6.04
Industry	82295.00	70130	-12165.00	-14.78
Housing	737.00	314.03	-422.97	-57.39
Healthcare	100.00	98.46	-1.54	-1.54
Communication	19051.00	21800	2749.00	14.43
Intermediation	128.00	116.05	-11.95	-9.34
Education	936.00	841.81	-94.19	-10.06
Recreation	1815.00	1998.9	183.90	10.13
Other services	355.00	318.31	-36.69	-10.34
Total	124392.00	118896.76	-5495.24	-4.42

Table 7.Simualtion results: change in imports

Sector	Imports, mln UAH		Change	
	Reference	Simulation	mln. UAH	%

	(tariff=10%)	(tariff=0)		
Food	6326.00	10700.00	4374.00	69.14
Energy	32981.00	36520.00	3539.00	10.73
Industry	60987.00	65330.00	4343.00	7.12
Housing	1189.00	595.70	-593.30	-49.90
Healthcare	153.00	168.78	15.78	10.31
Communication	4002.00	6007.00	2005.00	50.10
Intermediation	1364.00	1324.10	-39.90	-2.93
Education	3182.00	3204.00	22.00	0.69
Recreation	1774.00	2380.50	606.50	34.19
Other services	2543.00	2559.10	16.10	0.63
Total	114501.00	128789.18	14288.18	12.48

3. Poverty analysis.

Table 8 shows changes in relative prices of factors of production – labor and capital. Relative price of labor decreased by 2%, while relative price of capital increased by 9%.

Table 8. Simulation results: relative prices of factors

Factor	Benchmark	Simulation
Labor	1	0.98
Capital	1	1.09

Those households that obtain all their income from sources classified in the model as capital income (see table A2 for income reconciliation) are definitely better off. And households that rely only on labor income are worse off. The all households from the household survey are present in the CGE microsimulation model, the information on each household's labor and capital income after the simulation is available. As the factor markets in the model are not segmented and the benchmark relative prices of two factors are set to 1, labor and capital income of all households will fall by 2% and rise by 9% respectively. The total income effect on each household depends on initial factor endowments, and total effect on population depends also on sample weights.

I used household income vectors generated by simulation and reference income vectors to calculate the normalized, adult-adjusted FGT poverty measures. Transfers were held fixed in the model and all households that depend only on transfers were discarded. The sample weights used for the calculations are the sample weights from the model, not from the survey. The following table displays the calculated FGT indices for absolute poverty line of 2000 UAH per working individual. The overall effect of import tariff reduction is positive in terms of poverty, though small in magnitude. Poverty gap and poverty severity also decreased.

Table 9. Simulation results: FGT indices ($\overline{P}_\alpha$)

	$\overline{P}_\alpha$		
	$\alpha = 0$	$\alpha = 1$	$\alpha = 2$
Simulation	0.1508	0.0452	0.0211
Benchmark	0.1515	0.0456	0.0213

It must be noted that the model presented here is tentative. It ignores a large number of peculiarities of Ukrainian economy; including corruption, shadow economy etc. The simulation of the WTO accession is limited to tariff reduction. The Ukrainian exports are subject to different discriminatory policies, and as a member of WTO Ukraine will definitely experience increase of export demands. There is also one important shortcoming of the model in terms of application to poverty analysis is the structure of SAM. For example, a share of food expenditures in total households' expenditures is much more than 10%, while there is 1 (of 10) food sector in the SAM. This flaw, however, follows from the IO structure.

CONCLUSIONS

A CGE microsimulation model provides a deeper insight into household behavior that an ordinary CGE model. It allows combining simulation possibilities of GE modeling with analytical possibilities of a household survey and permits much more detailed poverty analysis that a CGE model with few households. Creating a CGE microsimulation model is more complicated process than creating an ordinary CGE model, as it requires household surveys data in addition to an IO data used. The household survey contains micro level data and its reconciliation and adjustment to macro level is a multistage process.

In this paper I applied a CGE microsimulation methodology to Ukrainian data and tried to examine how import tariff reduction may influence households' income. Using the simple static model, I simulated the impact of tariff reduction on income of each household in the survey. The 10% tariff reduction is supposed to decrease overall poverty. However, those households that depend only on labor income are worse off comparing to those depending on only capital income. The estimated decrease in poverty level is quite small.

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APPENDIX A. DATA RECONCILIATION

Table A1. Reconciliation of consumption

Sector in SAM	IO table accounts	Consumption items from HBS
Foodstuffs	Agriculture and hunting, fishery, food processing industry.	All expenditures on food, alcohol and tobacco
Energy sector	Mining of coal and peat, Productions of hydrocarbons, Electric energy ,Gas supply, Heat supply, Forestry	All expenditures on gas, electricity and fuel for heating, including firewood
Industry and trade sector	Productions of non-energy materials, Textile and leather industry, Woodworking, pulp and paper industry, publishing, Manufacture of coke products, Petroleum refinement, Other production, Manufacture of other non-metallic mineral products, Metallurgy and metal processing , Manufacture of machinery and equipment, Manufacture of chemicals, rubber and plastic products, Trade	All expenditures on industrial goods, including cloth, furniture etc.
Housing	Water supply, Construction, Renting, Real estate transactions, Sewage, cleaning of streets and refuse disposal	All expenditures on renting and upkeep of own housing
Healthcare	Health care and social assistance	All expenditures on medical and social assistance
Transport and communication	Transport, Post and telecommunications	All expenditures on transport and communications
Financial intermediation	Financial intermediation	Insurance and financial services
Education	Education, Research and development, Informatisation activities	Education services
Recreation	Hotels and restaurants, Recreational, entertainment, cultural and sporting activities	All expenditures on recreation, hotels, living outside own housing
Other services	Services to legal entities, Public administration, Other activities, Social activities	Personal care and other services

Table A2. Reconciliation of income

Income category in model	Income category in household survey
Labor income	Wages including in-kind wage payments
Capital income	Income from entrepreneurial and individual activity Income from selling agricultural products Dividends, interests, rent payments
Transfers	Pensions, stipends, subsidies and other transfers from government and other households

APPENDIX B. UKRAINIAN SAM OF 2002

Table B1. Intermediate use

		1	2	3	4	5	6	7	8	9	10
FOOD	**1**	53364	50	1310	40	952	236	5	643	940	580
ENERGY	**2**	2838	14815	41867	2468	642	4496	53	1042	219	779
INDUSTRY	**3**	29548	8238	93686	10539	1772	6355	765	1800	444	2670
HOUSING	**4**	1331	376	2210	1377	257	588	135	445	190	571
HEALTHCARE	**5**	120	121	238	86	129	210	11	21	19	89
COMMUNICATION	**6**	2720	2301	10450	1125	318	4179	312	422	305	1072
INTERMEDIATION	**7**	356	449	3689	519	47	1032	4701	83	81	215
EDUCATION	**8**	417	383	1613	272	485	1012	122	1239	249	1505
RECREATION	**9**	129	104	700	154	23	292	56	105	690	290
SERVICES	**10**	1361	497	4735	741	94	1023	738	442	370	884
total		92184	27334	160498	17321	4719	19423	6898	6242	3507	8655

Table B2. Value added

	1	2	3	4	5	6	7	8	9	10	
Wage	9187	9865	31351	8288	5377	14065	2457	9732	2045	10750	103117
Taxes	9948	3604	9461	2669	48	3458	130	281	815	350	30764
Subsidies	-447	-1894	-93	-202	-36	-128	0	-24	-301	0	-3125
Gross operating surplus	28690	9885	24234	6872	1988	13122	463	4074	1101	4625	98202
GDP	47378	21460	21460	17627	7377	30517	3050	14063	3660	15725	182317
Output	139562	48794	181958	34948	12096	49940	9948	20305	7167	24380	572591

Table B3. Final consumption

	HH	public	INV	EX	IM	subtotal	total
FOOD	64859	1099	5431	16379	-6326	81442	139562
ENERGY	7599	1490	871	2596	-32981	-20425	48794
INDUSTRY	30057	404	17865	82295	-60987	69634	225451
HOUSING	4398	2656	20866	737	-1189	27468	34948
HEALTHCARE	1751	9354	0	100	-153	11052	12096
COMMUNICATION	9497	2190	0	19051	-4002	26736	49940
INTERMEDIATION	12	0	0	128	-1364	-1224	9948
EDUCATION	2347	12358	549	936	-3182	13008	20305
RECREATION	2818	1753	12	1815	-1774	4624	7167
SERVICES	1222	14461	0	355	-2543	13495	24380
total	124560	45765	45594	124392	-114501	225810	572591