The EU-Ukraine trade liberalization: How much do the costs of tariff elimination matter?

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Contents

List of Tables

List of Figures

Abstract

The establishment of the currently negotiated Free Trade Agreement (FTA) between the EU and Ukraine is the next significant step towards Ukraine's deeper integration into the world economy, widely expected to result in additional welfare gains. As developing countries face some costs associated with trade liberalization, this paper contributes to the literature by analyzing the effects of the EU-Ukraine FTA taking into account the loss of tariff revenues as well as the changed economic conditions after Ukraine's accession to the WTO in 2008. In particular, we calculate the effects of a unilateral tariff elimination in a Computable General Equilibrium (CGE) model for Ukraine simulating three scenarios reflecting different means to compensate for the loss in tariff revenues. It turns out to be important to take these costs into consideration while modeling trade liberalization, as the results vary significantly across the scenarios. In general, we find that tariff elimination has only a small impact on the country's welfare because of the already strongly reduced tariff rates after Ukraine's WTO accession. The effects can even be negative if the country tries to refinance the trade liberalization costs by means of tax policy. According to our simulations the most welfare enhancing option would be the provision of financial support by the EU, which is in fact suggested in the latest European Parliament resolution.

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1 Introduction

After Ukraine's accession to the WTO in 2008 the creation of a Free Trade Agreement (FTA) between Ukraine and its most important trading partner the European Union (EU)[4] is the next significant and realistic step towards Ukraine's deeper integration into the world economy. The WTO accession has already caused major changes especially in the field of tariff reductions but it was also considered to be a prerequisite for the negotiations on the deep and comprehensive FTA (DCFTA), which began in February 2008 within the framework of the Association Agreement (AA). So far there have been 21 rounds of negotiations and, despite of condemned political events in Ukraine, the European Parliament stated in its recent resolution that the EU-Ukraine AA should be rapidly initialled, preferably by the end of 2011. The signing of the agreement is intended for the first half of 2012 and the ratification stage should be completed by the end of 2012.[5]

Theory suggests that trade liberalization is beneficial and the problems as well as costs of reducing trade barriers are mostly neglected in literature. However, they should especially be taken into consideration in case of developing countries like Ukraine. Reduced tariffs cause a loss of the tariff revenues and induce economic and social problems due to disruptions in agriculture. As these effects might lead to nations being worse off, developing countries might decide not to liberalize foreign trade.[6]

In this paper we focus on one of the most obvious and important costs of trade liberalization - the loss of tariff revenues. We analyze different scenarios simulating various options to compensate the lost revenues. In particular, we calculate the effects of a unilateral import tariff elimination on the welfare and trade flows in a Computable General Equilibrium (CGE) model for Ukraine.

One might wonder why in case of a bilateral agreement, only a unilateral tariff elimination is examined. The reason for this is that according to Weisbrot and Baker (2002) "[. . .] most of the projected gains from trade liberalization do not come from the removal of trade barriers in the industrialized countries - rather the biggest source of gains to developing countries is the removal of their own barriers to trade." To realize these gains it is basically irrelevant whether the industrialized country - in our case the EU - also liberalizes its trade or not.

The paper is organized as follows. The next section provides an overview of the existing literature. The structure of the model is described in section 3 followed by the specification of the data sources and the policy experiments. A detailed analysis of the results is given in section 5 including some robustness checks. The last section concludes with some policy implications.

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[4] To put it correctly, if the European Union would not be considered as one single trading partner, Russia would be on top.

[5] See European Parliament (2011) available at $http://www.europarl.europa.eu/plenary/en/texts-adopted.html$.

[6] See Weisbrot and Baker (2002).

2 Literature overview

The different forms of Ukraine's integration into the world economy are widely evaluated. Most previous studies are devoted to the WTO accession. In the framework of a standard CGE model Pavel et al. (2004) simulate the full WTO accession of Ukraine including tariff reduction, improved market access and adjustments of domestic taxation and identify a significant welfare gain and an increase in real GDP. These findings are supported by Jensen et al. (2005) who predict an overall welfare gain of 5.2% of Ukrainian consumption and a rise of real GDP by 2.4% in a modified model (e.g. some sectors produce under increasing returns to scale). Kosse (2002) confirms that the tariff reduction is indeed the most important part of the full WTO accession. She separately analyzes the impact of an import tariff reduction on national welfare and finds the WTO membership to be beneficial for Ukraine.

Subsequent studies focus on Ukraine's trade relations with the EU, especially after the ten Central and Eastern European countries joined the EU in 2004. An analysis of the different FTAs between Ukraine and the EU shows that the DCFTA, which additionally incorporates the harmonization of the Ukrainian norms and standards, would have a stronger positive impact on Ukraine's welfare compared to the simple one where the overall welfare effects are small or even slightly negative.[7] In a more recent study Maliszewska et al. (2009) model the impact of the different FTAs between the five European Neighborhood Policy (ENP) countries (Armenia, Azerbaijan, Georgia, Ukraine and Russia) and the EU. The conclusions are similar to the ones in the previous study. Among the ENP countries, Ukraine gains most from the simple FTA with a net welfare increase of 1.73%. But it could benefit even more from a DCFTA (increase of welfare by 5.83%). Francois and Manchin (2009) study the same question for the CIS region and Ukraine as a country study, but they find negative real income effects for the CIS and Ukraine (-0.83% and -2.12%, respectively) in case of the classical FTA simulation and a decrease of Ukrainian real income by 0.4% even under the DCFTA scenario. The most recent study on the Ukraine-EU FTA is done by von Cramon-Taubadel et al. (2010) for the World Bank. Using the GTAP model and dataset they mainly focus on the agricultural sector and find that a 50% reduction in all bilateral tariffs would only result in moderate gains for Ukraine and the EU. Note that the last two papers are some of the very few ones to consider Ukraine's final WTO commitments by simulating the changes after the accession.

These studies do not state clearly how they deal with the costs resulting from the tariff elimination.[8] This issue is addressed by Weisbrot and Baker (2002). They argue that one substantial problem in reducing trade barriers is the loss of revenues due to a reduction or elimination of tariffs. This especially applies to developing countries as tariff revenues

[7] See Emerson et al. (2006) and Ecorys and CASE-Ukraine (2007).

[8] The general and mostly applied method to deal with reduced tariff revenues in a CGE model is to increase lump sum taxes. But this is an unrealistic assumption because lump sum taxes are an artificial construct (see von Cramon-Taubadel et al. (2010)).

account for a considerable share of the national budget. For instance, due to the Ukrainian treasury report[9] the tariff revenues amount to 4.5% of the public budget. Following this argument our paper contributes to the ongoing discussion in two ways. First, it complements the only very scarce research on the effects of the EU-Ukraine FTA incorporating the changed economic conditions *after* Ukraine's WTO accession in 2008. Second, we explicitly account for the loss of tariff revenues as one of the most important costs of trade liberalization in case of a developing country and evaluate different modes of compensation for these losses.

3 Model description

Our model updates and extends the static CGE model of Pavel et al. (2004). In addition to the updated database the modifications include the creation of new trading regions and production sectors, the disaggregation of the representative household into four types and the implementation of sector-specific capital. It is implemented in GAMS/MPSGE[10] and considers 38 sectors, four types of households, the government, investments and nine trading regions. The structure of the model is shown in Figure 3.1.

The supply side of the Ukrainian economy is characterized by the assumptions of perfect competition and constant returns to scale. There are four factors of production: skilled and unskilled labor ($l_{s,i}$), capital (k_i) and sector-specific capital. Labor and capital (except sector-specific capital in the state-owned mining (a04) and pipeline transportation (a24P)) are perfectly mobile across sectors. The top nest of the production function is characterized by a Leontief-type structure:

$$y_i = min\{VA_i, ID_{i,j}\}, \tag{1}$$

where y_i represents the total output of sector i (including domestic sales and exports), $ID_{i,j}$ is the intermediate demand for good j by industry i, and VA_i is the value added that is given by the Cobb-Douglas function:

$$VA_i = c\, k_i^{(1-\sum_s \alpha_{s,i})} \prod_s l_{s,i}^{\alpha_{s,i}}, \quad 0 \leq \alpha_{s,i} \leq 1, \quad \sum_s \alpha_{s,i} < 1, \quad c > 0. \tag{2}$$

The subscript s denotes the two types of labor: skilled and unskilled. Intermediate inputs are either produced domestically or imported. Each firm uses a CES composite of domestic and imported intermediate inputs.[11] Producers maximize profits subject to their production technology.

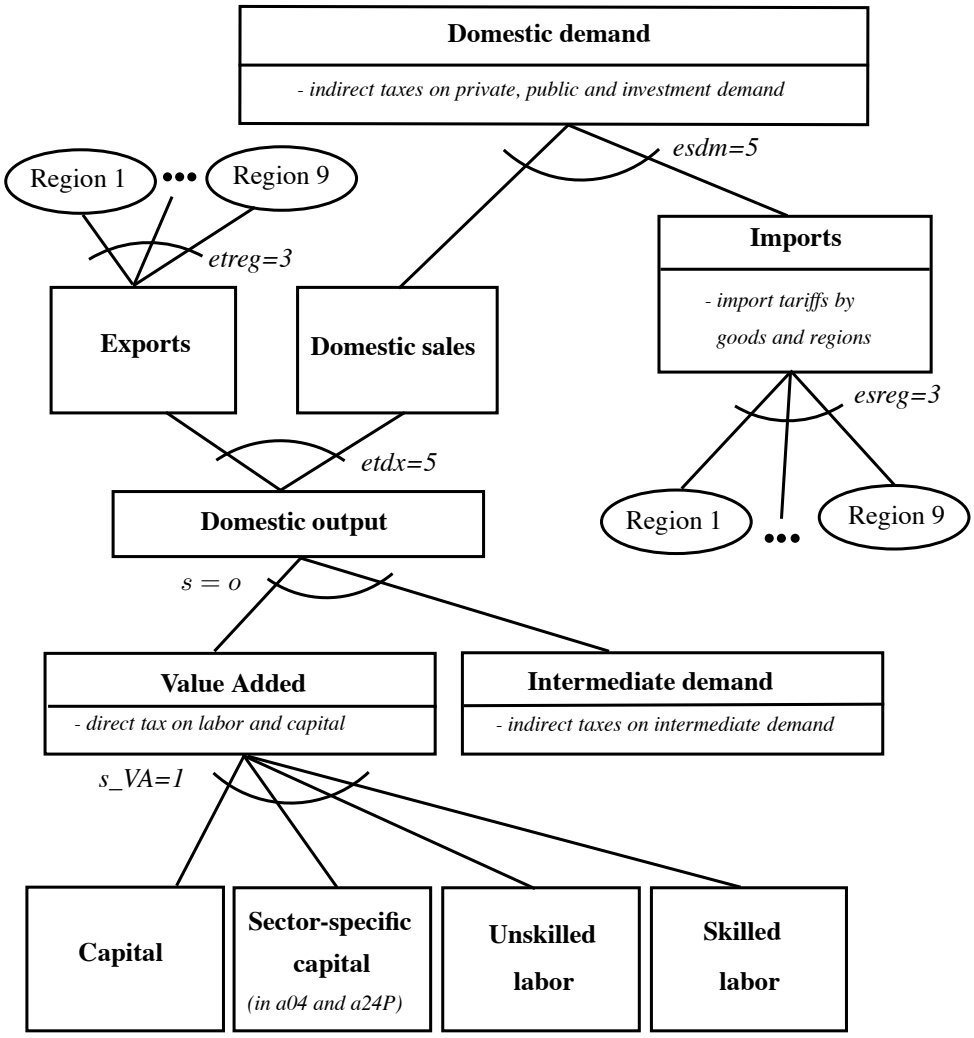
Each sector is assumed to produce a single homogeneous product, which can be sold on domestic (H_i) or foreign (EX_i) markets according to the constant elasticity of trans-

[9] The report of the Accounting Chamber of Ukraine for 2007 is available in ukrainian at $http://www.ac-rada.gov.ua/control/main/uk/publish/article/1126693;jsessionid=65AD9325C838702DD8808F622567899D$.

[10] See Rutherford (1999) and Boehringer et al. (2003).

[11] See equation (4).

Figure 3.1: **Model structure**



formation (CET) function:

$$Y_i = \psi_i(\gamma H_i^{\rho_{EX}} + (1-\gamma)EX_i^{\rho_{EX}})^{\frac{1}{\rho_{EX}}}, \quad \psi_i > 0, \quad 0 < \gamma < 1, \tag{3}$$

with $\rho_{EX} = (\sigma_{EX} - 1)/\sigma_{EX}$, where σ_{EX} defines the elasticity of transformation between domestic output and exports (in GAMS-Code: etdx=5). Producers regard sales on domestic markets and exports as imperfect alternatives. The output price index of each sector i is determined by both domestic $(p_{H,i})$ and export prices $(p_{EX,i})$: $\hat{p}_i = f(p_{H,i}, p_{EX,i})$, and the export price is defined as the FOB world market price $(\overline{p}_{EX,i})$ multiplied with the price of foreign exchange (p_{fx}): $p_{EX,i} = \overline{p}_{EX,i} p_{fx}$. Demanded goods are either imported (IM_j) or produced domestically (D_j) so that domestic supply (DS_j) is described by the constant elasticity of substitution (CES) function:

$$DS_j = \psi_j(\beta D_j^{\rho_{IM}} + (1-\beta)IM_j^{\rho_{IM}})^{\frac{1}{\rho_{IM}}}, \quad \psi_j > 0, \quad 0 < \beta < 1, \tag{4}$$

with $\rho_{IM} = (\sigma_{IM} - 1)/\sigma_{IM}$, where σ_{IM} defines the elasticity of substitution between imports and domestic goods (in GAMS-Code: esdm=5). This means that consumer preferences are modeled as Armington-style product differentiation.[12] The domestic price index of each good j is determined by the domestic sales price $(p_{D,j})$, the import price $(p_{IM,j})$ and the import tariff $(\tau_{IM,j})$: $p_j = f(p_{D,j}, p_{IM,j}(1 + \tau_{IM,j}))$. The import price equals the CIF world market price $(\overline{p}_{IM,j})$ multiplied with the price of foreign exchange (p_{fx}): $p_{IM,j} = \overline{p}_{IM,j} p_{fx}$.

The consumption side is represented by public consumption, investment and intermediate consumption as well as by final consumption of households. A representative household derives utility from consumption of goods and services and finances its total consumption by income from labor $(\sum_s w_s \overline{L})$ and capital endowments $(r\overline{K})$ and by received transfers from the government (T^G_{hh}) and from abroad (T^a_{hh}). This means that the value of total consumption of a representative household $(\Sigma_j C_j p_j (1 + \tau_j))$[13] does not exceed the income multiplied with the total share of consumption $(\theta, 0 < \theta < 1)$:

$$\sum_j C_j p_j (1 + \tau_j) \leq \theta \left[\sum_s w_s \overline{L} + r\overline{K} + T^G_{hh} + T^a_{hh} \right] \tag{5}$$

The representative household of the model is disaggregated into four types according to the poverty line and the place of residence[14]: non-poor urban and rural households, poor urban and rural households. Non-poor households are endowed with both capital and labor (skilled and unskilled) whereas poor households are only endowed with unskilled labor. All households receive transfers from the government and pay taxes and social security contributions. But only non-poor households receive transfers from abroad and save a constant share of their income.

The government receives income from public capital endowments[15] $(rK_p + r_{sp}K_{sp})$, revenue from direct $(\sum_i \tau_i (rk_i + \sum_s w_{s,i} l_i))$ and indirect taxes $(\sum_j \tau_j p_j (C_j + INV_j + ID_j + G_j + EX_j))$, from import tariffs $(\sum_{j,r} \tau_{IM,j,r} p_{IM,j} IM_{j,r})$, transfers from abroad (T^a_G) and from households (T^{hh}_G). Direct taxes are modeled as sector-specific taxes on the use of production factors (capital and labor). Indirect taxes, in contrast, are modeled as product-specific taxes on private (C_j), investment (INV_j), intermediate (ID_j) and public (G_j) demand as well as on exports (EX_j). Import tariffs $(\tau_{IM,j,r})$ are product-specific and distinguished by region. Government's income is used for savings $(p_{inv} SAV^G)$, transfers to households (T^G_{hh}) and to abroad (T^G_a), and to provide public services[16] $(\sum_j p_j G_j)$. The

[12] This assumption is based on Armington (1969). See also Dervis et al. (1982), p. 221-223, 226-227.

[13] C_j is the consumption of good j and τ_j represents consumption tax rate for good j.

[14] The poverty line is calculated following the methodology of the Ministry of Economy of Ukraine (available in Ukrainian at $http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=z0401-02$).

[15] Including capital income in state-owned sectors with sector-specific capital $(r_{sp}K_{sp})$: mining and pipeline transportation (a04 and a24P).

[16] Consumption levels of public services are determined by a Cobb-Douglas function.

public budget constraint is given by:

$$rK_p + r_{sp}K_{sp} + \sum_i \tau_i(rk_i + \sum_s w_{s,i}l_i) + \sum_j \tau_j p_j(C_j + INV_j + ID_j + G_j + EX_j)$$

$$+ \sum_{j,r} \tau_{IM,j,r} p_{IM,j} IM_{j,r} + T_G^a + T_G^{hh} \tag{6}$$

$$= p_{inv} SAV^G + T_{hh}^G + T_a^G + \sum_j p_j G_j.$$

Aggregate investment is modeled as a Cobb-Douglas composite over all goods j:

$$INV = \psi \prod_j INV_j^{\phi_j}, \quad \phi_j \geq 0, \quad \sum_j \phi_j = 1, \quad \psi > 0. \tag{7}$$

The price index for one unit of the aggregate investment good is given by: $p_{inv} = f(p_j(1+\tau_j))$. The sum of public ($SAV^G$) and private savings ($SAV^{hh}$) equals aggregate investment:[17]

$$p_{inv}(SAV^G + SAV^{hh}) = p_{inv} INV. \tag{8}$$

Equilibrium is defined by zero profits for producers, balanced budgets for households and the government, and by market clearing for all goods and factor markets. For equalization of the balance of payments, it must be valid that the CIF value of imports together with transfers from the government to abroad (T_a^G) are equal to the FOB value of exports plus transfers from abroad to households (T_{hh}^a) and to the government (T_G^a):

$$\sum_j \overline{p}_{IM,j} IM_j + T_a^G = \sum_i \overline{p}_{EX,i} EX_i + T_{hh}^a + T_G^a. \tag{9}$$

The price of foreign exchange (p_{fx}) is chosen as the numeraire.

This model description gives a picture of all economic flows among the agents and does not represent the explicitly programmed algebraic equations as we use the MPSGE subsystem, which automatically generates the equations of the model based on reference prices, quantities and elasticities.[18]

4 Data and policy experiments

The base year of our analysis is 2007 as we try to avoid the influence of the world economic crises. The backbone of the model is formed by a Social Accounting Matrix (SAM)[19] with 38 sectors. It was constructed with the data of the Ukrainian National Accounts and Input-Output Tables for 2007 at basic and consumer prices (publications

[17] We do not consider the current account balance in the model as the data set is adjusted in the way that there are no imbalances.
[18] See Rutherford and Paltsev (1999) and Rutherford (1999).
[19] See Pyatt and Round (1985).

of the State Statistics Committee of Ukraine).[20] A SAM must be a balanced matrix so that the row sums equal the corresponding column sums. As the SAM for Ukraine was not balanced in the first version (due to inconsistency of data sources), we used a few balancing items in order to match all rows and columns.

Additional information on indirect taxes, subsidies and imports (separately for intermediate, private, public and investment demand) as well as information on services trade flows are also taken from the publication of the State Statistics Committee of Ukraine. Labor remuneration is disaggregated with data from this source as well.

The consumption shares per household type and sector are calculated from the Derzhkomstat[21] household budget survey for 2007 covering more than 10,000 Ukrainian households and over 200 different commodity groups (COICOP classification). Using these data the shares of payments from households to government as well as the shares of transfers from the government to poor households in their total expenditures are computed. The respective figures are listed in Table 4.1.

Table 4.1: **Shares for household disaggregation (in %)**

type of household (h)	non-poor urban	non-poor rural	poor urban	poor rural
division of transfers from households to government*	74	14	2	10
shares of transfers from government in household's expenditures			35	35

*Transfers include taxes and social contributions.

Table 4.2: **Model elasticities**

Parameter	Value	Description
s	0	Elasticity of substitution between value added and intermediate inputs
s_VA	1	Elasticity of substitution between primary factors: capital and labor
esdm	5	Armington elasticity of substitution between imports and domestic goods
etdx	5	Elasticity of transformation between domestic production and exports
esreg	3	Elasticity of substitution between import origin
etreg	3	Elasticity of transformation between export destination

Source: Pavel (2004), p. 4.

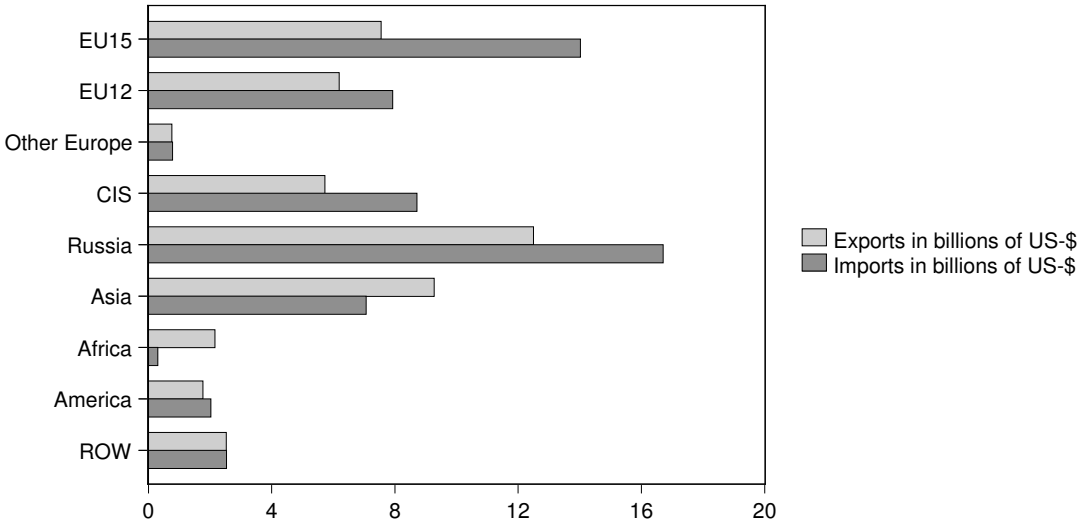
All elasticities of substitution and transformation are taken from Pavel et al. (2004) and presented in Table 4.2. Data on Ukrainian commodity trade flows are drawn from the United Nations Commodity Trade Statistics Database (Comtrade). These data were aggregated into 17 (b01-b017) commodity groups. We used different correspondence tables

[20] Concerning the sectoral structure two changes were made in the SAM compared to the original Input-Output Table. The heat supply sector was added to the electric energy sector (a17) and the pipeline transit of oil and gas (a24P) was separated from the transportation sector.

[21] The State Statistics Committee of Ukraine.

to convert the data from the HS96 into the KVED classification (Ukrainian classification which is based on NACE Rev.1). Ukraine's exports and imports were grouped into the following nine trading regions: EU-15, EU-12, other Europe, Asia, Africa, America, Commonwealth of Independent States (CIS), Russia and the rest of the world (ROW). The first eight regions include countries representing the key trading partners of Ukraine with all other countries being summarized as the rest of the world.[22] Figure 4.1 illustrates the trade structure of Ukraine in 2007 and a detailed description of countries' aggregation into trading regions is given in Table A.1.

Figure 4.1: **Structure of Ukrainian commodity trade**



Information on import tariffs is taken from the Law of Ukraine "About the Customs Tariff of Ukraine" including all amendments made due to Ukraine's accession to the WTO in 2008. The law includes three types of tariff rates (ad valorem, specific and mixed). First, the ad valorem equivalents of the specific and mixed tariffs were calculated.[23] The resulting tariff rates were transformed from the HS2000 into the KVED classification using again correspondence tables and applying different averages (simple, weighted, import-weighted). Table 4.3 shows the calculated import tariffs. With an import-weighted MFN tariff rate of 13.66 percent the food-processing, beverages and tobacco sector is the most protected one.

Different trade regimes are included in the model. Commodity trade with Russia and other CIS countries is classified as free trade because of the existing FTA between Ukraine and the CIS countries.[24] The MFN status is applied to trade with all other regions as the included countries are either members of the WTO or have bilateral trade agreements with Ukraine to establish this trade regime.

[22] Exports and imports for the ROW region are obtained as a residual.
[23] Following WTO et al. (2007), p.187-188.
[24] The FTA was established in 1999.

Table 4.3: **Calculated import tariffs**

Sector	SAM code	Import-weighted MFN tariff*
Agriculture	b01	5,63
Forestry, logging and related service activities	b02	1,71
Fishing	b03	5,00
Mining of coal and peat	b04	0,00
Production of hydrocarbons	b05	0,50
Mining and quarrying	b06	2,23
Food-processing	b07	13,66
Textile industry	b08	8,06
Wood industry	b09	0,98
Manufacture of coke products	b10	1,61
Petroleum refinement	b11	1,64
Chemical industry	b12	3,71
Other non-metallic products	b13	7,07
Metallurgy, metal processing	b14	1,93
Machine-building	b15	3,09
Other production	b16	1,85
Electric energy	b17	3,50

*These tariff rates apply to all trading regions except for Russia and CIS.

As the purpose of this paper is to quantify trade liberalization effects between Ukraine and the EU taking into account that lost tariff revenues[25] have to be compensated, we model three different scenarios reflecting three possibilities to deal with this problem. All three scenarios have in common the elimination of the import tariffs in all commodity groups for two regions in the model: EU-12 and EU-15. For all other regions the estimated tariff rates are still valid.

In scenario 1 (S1) there is no possibility for the government to compensate the loss in tariff revenues meaning that there is no endogenous adjustment. Therefore the elimination of Ukraine's import tariffs with respect to the EU goods has to result in a decrease of the government spending.[26]

In contrast, in scenario 2 (S2) the government is assumed to use its power to enforce an increase in the indirect tax rate meaning that the public consumption can be hold constant.

In scenario 3 (S3) we allow the government to gain additional foreign aid as the EU intends to provide Ukraine with financial as well as technical and legal assistance.[27] This means that despite the decrease of tariff revenues neither the public expenditures have to be reduced nor the indirect tax rate has to be increased.

[25] In the benchmark scenario tariff revenues amount to 4.03% of the public budget.
[26] Note that this is not a realistic scenario as politicians might try to avoid such unpopular reforms.
[27] See European Parliament (2011), article 1(e).

5 Simulation results

The results of our comparative static evaluation of the tariff elimination between Ukraine and the EU describe the full adjustment of the Ukrainian economy after the external shock of tariff elimination. This process is typically understood as a medium-term perspective over 7-10 years. Moreover, according to the CGE modeling framework the estimated results represent the isolated impacts of the trade liberalization on Ukraine's economy. The possible effects of all other events affecting the economic development (e.g. changes in energy and commodity prices, exchange rates, factor productivity, etc.) are not considered. All results of our policy experiment reflect changes of the respective variables compared to the benchmark year 2007.

5.1 Aggregate effects

Economy-wide results of the counterfactual experiments are illustrated in Table 5.1. The elimination of Ukraine's import tariffs causes a decline of relative import prices and a reduction of the tariff revenue in all scenarios. The resulting tariff revenues as a share of the Ukrainian public budget are between 1.65% and 1.70%, compared to 4.03% in the benchmark scenario.

As in the first scenario we do not allow the government to compensate these revenue losses, the public services provision must be reduced by 1.93% in order to fulfill the government's budget constraint. The second scenario assumes that the government uses its power to enforce an increase in the indirect tax rate from 13.15% to 13.70% which ensures a constant supply of public services. In the third scenario, there is neither a reduction of the public services provision nor an increase in the indirect tax rate. The missing tariff revenues are compensated by additional foreign aid amounting to 2.699 billion UAH.

The decline of relative import prices induces a reduction in consumer prices for all household types in scenario 1 and 3, whereas in the second scenario this favorable effect is more than outweighed by the increased tax burden and the resulting consumer price increase by a maximum of 0.1% in case of rural households.

Concerning the production side, the tariff elimination causes a reallocation of the production factors across sectors and accordingly a shift in the production levels while aggregate real GDP remains almost unchanged in all scenarios. The uncompensated revenue losses in scenario 1 cause a complete change in the pattern of factor demand as the government cuts its spending for the provision of services such as public administration (a32), education (a33), health care and social assistance (a34).[28] This means a strong decrease of output[29] and, consequently, of factor demand in these sectors, which constitute the skilled labor-intensive production according to Tables A.3 and A.2.[30] That is why the

[28] These sectors account for 82.8% of government spending (see Table A.4).
[29] See Figure 5.2 or Table A.5.
[30] Table A.3 indicates labor intensity for the three aforementioned sectors and Table A.2

Table 5.1: **Aggregate results**

Variable	S0	S1	S2	S3
Tariff revenue (share of public budget, in %)	4.03	1.70	1.65	1.66
Public services provision (change in %)	-	-1.93	0.00	0.00
Indirect tax rate (weighted average, in %)	13.15	13.15	13.70	13.15
Price index for households' consumption composites (change in %):				
- Urban households	-	-0.41	0.07	-0.39
- Rural households	-	-0.47	0.10	-0.44
- Urban poor households	-	-0.40	0.05	-0.37
- Rural poor households	-	-0.44	0.08	-0.42
Real GDP (change in %)	-	0.00	0.00	0.00
Real factor return (change in %):				
- Return to capital	-	0.23	-0.08	0.10
- Return to sector-specific capital in mining (a04)	-	1.18	0.74	0.51
- Return to sector-specific capital in pipeline transit (a24P)	-	0.66	0.00	0.25
- Wage rate for unskilled labor	-	0.22	0.07	0.17
- Wage rate for skilled labor	-	-0.17	0.08	0.19
Welfare per household type (Hicksian welfare index, change in %):				
- Urban households	-	0.48	-0.07	0.55
- Rural households	-	0.54	-0.09	0.61
- Urban poor households	-	0.56	0.00	0.50
- Rural poor households	-	0.69	-0.01	0.60
Consumption per household type (UAH bn):				
- Urban households	273.128	274.453	272.945	274.636
- Rural households	96.059	96.579	95.971	96.644
- Urban poor households	33.717	33.905	33.717	33.884
- Rural poor households	26.715	26.898	26.712	26.876
Aggregate exports (UAH bn)	323.205	329.661	328.438	326.785
Aggregate imports (UAH bn)	364.373	370.829	369.606	370.658
Aggregate exports (change in %)	-	2.00	1.62	1.11
Aggregate imports (change in %)	-	1.77	1.44	1.72
Additional foreign aid (UAH bn)	-	-	-	2.699

wage rate for skilled labor decreases in scenario 1 by 0.17% while unskilled labor and capital receive higher factor returns of nearly 0.2%. In the second scenario, a shift in factor demand with unchanged public spending leads to a decrease of the return to capital by 0.08%, while labor remuneration grows slightly by 0.07% for unskilled and by 0.08% for skilled labor meaning that capital would lose in this case. The higher returns to labor (skilled and unskilled) compared to the return to capital in the third scenario together with factor remuneration results of scenario 2 indicate a deepening of Ukraine's specialization in the production of labor-intensive goods after trade liberalization.[31]

When interpreting the results concerning welfare, differing and partly opposing effects should be taken into consideration. Increases in factor remuneration and reduced con-

shows that the skilled labor demand is much higher in these industries compared to the unskilled labor type. These let us to conclude that public services are characterized by skilled labor-intensive production.

[31] Following the Heckscher-Ohlin and Stolper-Samuelson theorems, see Feenstra (2004), p. 15, 32, 174.

sumer prices are expected to stimulate consumption. In contrast, higher consumer prices and reduced factor returns should have a negative impact on welfare. Therefore, the question which effect dominates should be answered separately for each of the scenarios. The only welfare reducing effect in scenario 1 is the decreasing wage rate for skilled labor. Nonetheless, the positive effects prevail and the non-poor households' welfare is raised on average by 0.51%, whereas for poor households a somewhat higher welfare increase (on average 0.63%) is found. In scenario 2, the reduced return to capital and the negative effect of higher consumer prices dominate and our simulation suggests no change (for urban poor households) or even a small reduction of consumption by nearly 0.08% for non-poor and by approximately 0.01% for rural poor households. The stronger negative welfare effect of non-poor households is caused by their higher tax burden compared to the poor household types.[32] In case of scenario 3, all effects point in the same direction. There is a positive effect resulting from reduced consumer prices and all factors of production gain a higher return compared to the benchmark scenario. These lead to an increase in consumption and welfare of all household types. For non-poor households the average increase amounts to 0.58% and the respective value for the poor ones is 0.55%.

Not surprisingly, the strongest effect of the tariff elimination occurs in the foreign trade flows of Ukraine. Aggregate imports rise in all scenarios by up to 1.77% (S1) and stimulate an increase of exports in the range from 1.11% to 2%. Scenario 3 shows a somewhat lower rise of exports because foreign aid provides the economy with additional foreign currency needed for the purchase of increased imports.

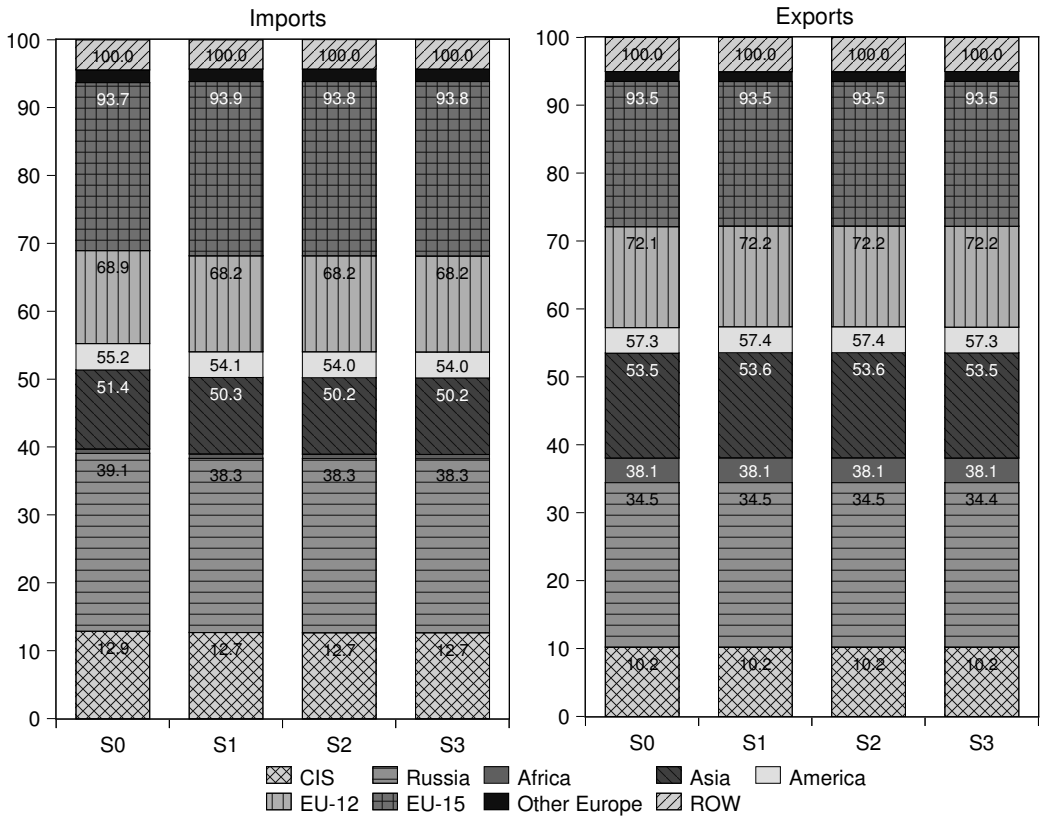
Despite of changes in aggregate imports and exports, the fundamental trade structure of Ukraine with the model-specific regions remains almost unchanged as illustrated in Figure 5.1. This means that there is no welfare reducing trade diversion as world prices remain unchanged in case of trade liberalization between the EU and Ukraine.[33] Nevertheless, the removal of import tariffs between Ukraine and the EU leads to a small increase of imports from the EU member countries (EU-15 and EU-12) by 1.37 percentage points on average for all simulations (from 38.4% to 39.8%) while the import shares of all other regions decline slightly. The strongest fall in import shares is observed for Russia (by nearly 0.53 percentage points). The results for the export structure suggest basically unchanged shares for all the regions.

5.2 Disaggregate results

Figure 5.2 and Table A.5 illustrate the changes in sectoral output, imports and exports for the different simulations. We observe that tariff elimination strongly favors Ukraine's chemical and textile industries, metallurgy, mining and quarrying and the manufacturing of coke products. These activities experience the strongest output increase in all simulations while a rise of production in sectors such as wood industry, mining of coal and

[32] See Table 4.1.
[33] See Kemp and Wan (1976), Feenstra (2004), p.192-196 and WTO (2011), p. 100-102.

Figure 5.1: **Regional structure of Ukrainian foreign trade**



peat and other production is still noteworthy. The output increase occurs in these sectors because they are relatively unprotected in the benchmark (see Table 4.3) and benefit from lower prices for intermediate goods which take over 50% of their total inputs (see Table A.2). Moreover, these winning sectors (except for manufacture of coke products and mining of coal) are export-oriented (see Table A.2) and gain additionally from trade liberalization because the tariff-elimination-induced demand for imports leads to a foreign exchange outflow and, consequently, to a stimulation of exports. In addition to the aforementioned activities, hotels and restaurants benefit mostly among the service sectors in each scenario because this sector is initially unprotected, exports nearly 51% of its output and gains from the elimination of the highest import tariff (13.66%) in the food industry (i.e. cheaper intermediate inputs). On the other hand, food-processing and production of non-metallic mineral products, agriculture, fishery and petroleum refinement reduce their output in all simulations because of a high initial level of protection and low export shares. Concerning services, there is only in scenario 1 a strong output decrease in public services, education, health care and social assistance, leisure activities, streets cleaning as well as in research and development what is driven by strongly reduced public spending in these sectors[34] due to the non-compensated revenue losses.

The development of exports and imports reflects the results for the output changes. Tar-

[34]See Table A.7.

iff removal leads to a rise of imports in the initially protected sectors (from agriculture up to electric energy) and across all scenarios[35]. Food-processing, production of non-metallic mineral products and agriculture have the highest degree of protection in the benchmark and are thus on the top of the import increasing sectors. This rise of import demand is accompanied in each simulation by an increase of exports in chemical and textile industry, metallurgy, wood industry, other production, mining and quarrying, machine building, and manufacture of coke products. In contrast, sectors as food-processing, production of non-metallic mineral products, petroleum refinement, agriculture and fishery reduce their exports in every simulation. Concerning foreign trade in services, the changes in imports and exports are small as all service activities are unprotected in the benchmark equilibrium. Nevertheless, hotels and restaurants as well as construction[36] constitute exceptions with a strong rise of exports by up to 1.72% and 1.44% (S1), respectively. Moreover, the aforementioned services with the decreased output experience also a decline of imports and exports in scenario 1 because of cuts in public spending.

The foreign trade results underline the specialization of Ukraine in labor-intensive goods as the majority of activities with increased exports produce with intensive use of labor inputs. As shown in Table A.3, these include chemical industry, metallurgy, wood industry, other production, machine building and manufacture of coke products. On the other hand, losing sectors such as food-processing, petroleum refinement and agriculture are characterized by capital-intensive production.[37] Hence, these results confirm the theoretical expectations that Ukraine, which is abundantly endowed with labor and poor in capital endowments, specializes in labor-intensive goods on world markets.

The results on factor and intermediate demand are presented in Table A.6 and are consistent with the output changes. The sectors with extended production after simulations raise their factor and intermediate demand as the rise of output needs an increased factor and intermediate input. On the contrary, demand for production factors and intermediate products declines in the sectors losing from trade liberalization[38].

Slightly inconsistent results across scenarios are observed in such industries as forestry and production of hydrocarbons. These sectors reduce their output and exports only in scenario 3, while imports rise. This phenomenon is related to the stronger import increase because of additional foreign aid in scenario 3. Moreover, we also observe some differences in prices, which lead to the presented results. In particular, import prices fall because of tariff elimination, but domestic supply prices rise in these industries because

[35] Except production of hydrocarbons in scenario 2 where we observe a slight decrease of imports because of price changes in this sector: the relative import price of hydrocarbons remains almost unchanged while the relative domestic supply price decreases.

[36] Construction gains from the elimination of import tariffs for non-metallic mineral products (initial value 7,07%) which allows for higher output and exports.

[37] Our data do not consider land as a separate production factor. This means that capital includes also land as an input for production.

[38] The strongest fall of factor and intermediate demand is observed in food-processing and production of non-metallic mineral products, agriculture, fishery and petroleum refinement.

of increased factor remuneration.[39] Concerning the third simulation, one notices that output changes for the initially protected sectors[40] are lower compared to the other scenarios. The reason is the additional foreign currency provided with the foreign aid which allows for increased import demand without a strong increase of exports and output.

[39] These sectors use much more labor and capital than intermediate inputs for production (see Table A.2), so that domestic supply prices increase with higher factor remuneration.
[40] These include the activities from agriculture up to electric energy and heat supply.

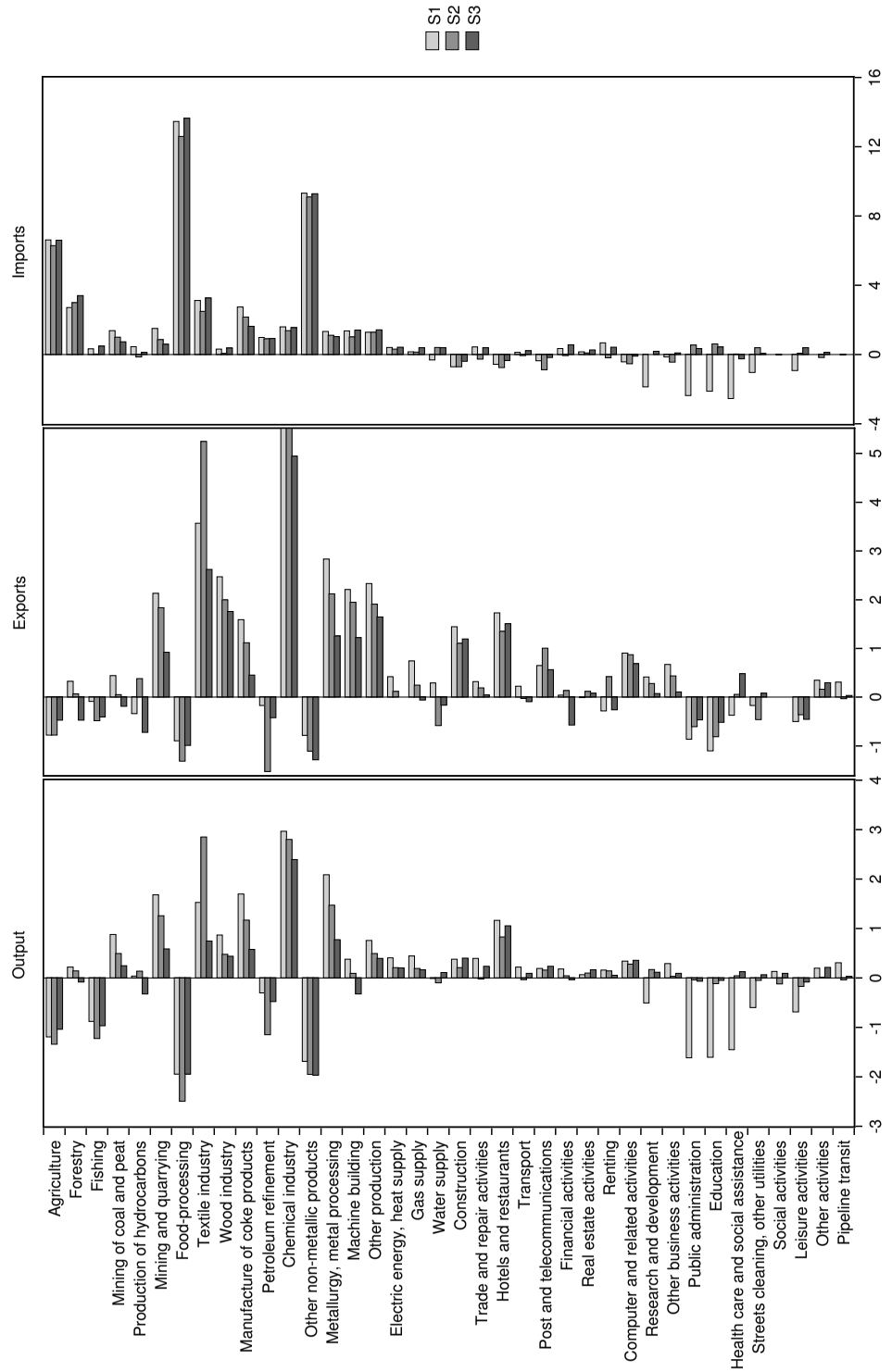


Figure 5.2: **Disaggregate results (change in %)**

5.3 Robustness and sensitivity analysis

To check the robustness of our results with respect to the underlying data and elasticity values we repeated our simulations with some changes. First of all, we conducted the counterfactual experiments with the data for 2004 examining whether the benchmark year 2007 was a *representative* year and if the choice of another base year before the world economic crisis would have led to significantly different results. Table 5.2 shows that the difference between the results is small or even negligible.[41] This confirms the robustness of our results and supports the general experience in CGE modeling that the choice of the base year has a minor impact on the robustness of simulation results.[42]

Table 5.2: **Simulation results for different base years**

Variable	S0	S1		S2		S3	
		2007	2004	2007	2004	2007	2004
Welfare per household type (Hicksian welfare index, change in %):							
- Urban households	-	0.48	0.53	-0.07	-0.13	0.55	0.57
- Rural households	-	0.54	0.59	-0.09	-0.13	0.61	0.62
- Urban poor households	-	0.56	0.65	0,00	-0.07	0.50	0.54
- Rural poor households	-	0.69	0.86	-0.01	0.01	0.60	0.70
Price index for Households' consumption composites (change in %):							
- Urban households	-	-0.41	-0.31	0.07	0.18	-0.39	-0.30
- Rural households	-	-0.47	-0.36	0.1	0.17	-0.44	-0.36
- Urban poor households	-	-0.4	-0.29	0.05	0.23	-0.37	-0.29
- Rural poor households	-	-0.44	-0.33	0.08	0.23	-0.42	-0.33

For examining the sensitivity of the represented results with respect to the elasticities of substitution and transformation we ran 1000 simulations for each scenario with randomly defined elasticity values taken from normal distribution centered at the initially assumed levels.[43] In particular, the elasticity of substitution between import origins (esreg) is chosen within the interval from 0.00001 to 6.0, while the Armington elasticity of substitution between imports and domestic goods (esdm) as well as the elasticity of transformation between domestic products and exports (etdx) range from 0.00001[44] to 10.0.[45] Furthermore,

[41] The only qualitative difference occurs in scenario 2 for rural poor households which increase their consumption by 0.01% in comparison with the reduction by 0.01% before. The reason is the benefit of these households from the higher increase (+0.22%) of the wage rate for unskilled labor (the sole production factor they are endowed with) in 2004.

[42] See Jensen et al. (2005), p. 25.

[43] A comparable sensitivity analysis can be found in Jensen and Tarr (2011).

[44] This value is chosen because Armington elasticities of zero are not theoretically possible.

[45] We have also tested the elasticity of transformation between export destinations (etreg) but there is no influence on the welfare changes and other macroeconomic results.

in every simulation we allow for a random combination of the aforementioned elasticities.

Table 5.3[46] summarizes the results of this robustness check for some macroeconomic aggregates. For each variable and scenario we report the minimum, maximum and mean value out of 1000 simulations, the lower and upper bound of the 95% confidence interval.[47] In addition, the table includes our initial simulation value and its relation to the confidence band as well as the relative deviation of the minimum and maximum values in the robustness check from the initial result. We find that all our simulation results lie within the 95% confidence interval and the robustness check values spread within an interval of less than 5% around the initial ones. Consequently, we consider our results to be robust with respect to the elasticity values. Nevertheless, the reported variables are more sensitive to different elasticity combinations in case of tariff elimination with endogenous adjustment of indirect taxes (scenario 2), as the lower and upper bound of the confidence interval suggest both, a possible decrease and increase of the price indices and welfare levels of the poor household types. This means that such a tariff reform as a source of funds for trade liberalization could lead to small positive or even negative welfare effects for poor households depending on substitutability and transformability of Ukrainian goods with foreign ones.

[46] All reported results except for deviations and trade flows are represented as raw simulation results and show changes relative to the benchmark values of 1.

[47] The 95% confidence interval is calculated for each scenario separately on the basis of robustness checks.

Table 5.3: **Robustness checks**

		Hicksian welfare index per household type				Price index per household type				Price index	Trade flows (UAH bn)	
		urban	rural	urban poor	rural poor	urban	rural	urban poor	rural poor	for government	exports	imports
S1	Min. value	1.0041	1.0046	1.0043	1.0059	0.9932	0.9927	0.9932	0.9929	0.9962	324.5345	365.7025
	Max. value	1.0053	1.0060	1.0069	1.0079	0.9981	0.9975	0.9984	0.9978	1.0000	334.9774	376.1454
	Mean value	1.0048	1.0054	1.0056	1.0068	0.9959	0.9953	0.9960	0.9956	0.9985	328.9800	370.1480
	Lower bound of the confidence interval (95%)	1.0043	1.0048	1.0045	1.0061	0.9937	0.9932	0.9937	0.9934	0.9967	325.2974	366.4654
	Upper bound of the confidence interval (95%)	1.0052	1.0059	1.0066	1.0076	0.9978	0.9972	0.9981	0.9975	0.9998	333.5936	374.7616
	Simulation value	1.0048	1.0054	1.0056	1.0069	0.9959	0.9953	0.9960	0.9956	0.9986	329.6608	370.8288
	Simulation value within the confidence interval	+	+	+	+	+	+	+	+	+	+	+
	Min. deviation	0.0007	0.0008	0.0013	0.0010	0.0027	0.0026	0.0028	0.0027	0.0023	0.0156	0.0138
	Max. deviation	0.0004	0.0006	0.0013	0.0010	0.0023	0.0022	0.0024	0.0022	0.0014	0.0161	0.0143
S2	Min. value	0.9988	0.9985	0.9982	0.9986	0.9976	0.9979	0.9973	0.9978	0.9987	323.3970	364.5650
	Max. value	0.9999	0.9997	1.0018	1.0010	1.0035	1.0037	1.0033	1.0036	1.0027	333.6468	374.8148
	Mean value	0.9993	0.9991	1.0000	0.9998	1.0007	1.0010	1.0005	1.0009	1.0010	327.7669	368.9349
	Lower bound of the confidence interval (95%)	0.9989	0.9986	0.9984	0.9987	0.9981	0.9984	0.9979	0.9983	0.9990	324.0303	365.1983
	Upper bound of the confidence interval (95%)	0.9998	0.9996	1.0014	1.0008	1.0032	1.0034	1.0030	1.0033	1.0025	332.2926	373.4606
	Simulation value	0.9993	0.9991	1.0000	0.9999	1.0007	1.0010	1.0005	1.0008	1.0010	328.4381	369.6061
	Simulation value within the confidence interval	+	+	+	+	+	+	+	+	+	+	+
	Min. deviation	0.0005	0.0006	0.0018	0.0013	0.0031	0.0030	0.0032	0.0031	0.0023	0.0153	0.0136
	Max. deviation	0.0006	0.0006	0.0017	0.0011	0.0028	0.0027	0.0028	0.0028	0.0017	0.0159	0.0141
S3	Min. value	1.0048	1.0053	0.9933	1.0053	0.9935	0.9931	0.9935	0.9932	0.9982	323.3970	364.5650
	Max. value	1.0160	1.0183	1.0063	1.0116	1.0390	1.0366	1.0404	1.0382	1.0437	333.6468	374.8148
	Mean value	1.0056	1.0061	1.0049	1.0060	0.9963	0.9958	0.9964	0.9960	1.0004	327.7669	368.9349
	Lower bound of the confidence interval (95%)	1.0050	1.0055	1.0037	1.0054	0.9940	0.9936	0.9941	0.9938	0.9985	324.0303	365.1983
	Upper bound of the confidence interval (95%)	1.0060	1.0067	1.0060	1.0067	0.9985	0.9978	0.9987	0.9981	1.0021	332.2926	373.4606
	Simulation value	1.0055	1.0061	1.0050	1.0060	0.9961	0.9956	0.9963	0.9958	1.0003	328.4381	369.6061
	Simulation value within the confidence interval	+	+	+	+	+	+	+	+	+	+	+
	Min. deviation	0.0007	0.0008	0.0117	0.0007	0.0027	0.0025	0.0028	0.0026	0.0020	0.0153	0.0136
	Max. deviation	0.0105	0.0122	0.0014	0.0055	0.0430	0.0412	0.0443	0.0425	0.0434	0.0159	0.0141

6 Summary and policy implications

The simulation of trade liberalization between Ukraine and the EU confirms that it is indeed important to consider the costs of liberalization. Including different possibilities to compensate the loss in tariff revenues in a CGE model we calculate the effects of Ukraine liberalizing its trade with the EU unilaterally.

Briefly summarized, we obtain the following results: while real GDP is almost unaffected in all scenarios, welfare effects differ significantly ranging from -0.09% to 0.69%, depending on the mode of compensation. These differences are mainly driven by the rise of the consumer prices resulting from an increase in the indirect tax rate in scenario 2. As this is ruled out by assumption in the other scenarios, the tariff elimination would be welfare enhancing in the uncompensated scenario (S1) and the aid-compensated scenario (S3), even though the magnitude varies. This reflects the reallocation of factors across sectors and the related change in demand and remuneration of production factors, which turn out differently in S1 and S3. Despite these differing results after the trade liberalization, an overall deepening of Ukraine's specialization in the production of labor-intensive goods can be identified. The majority of sectors, which gain from trade liberalization because of an increase in production and exports, are labor-intensive. Among these are the chemical industry, metallurgy, wood industry, machine building and manufacture of coke products. Regarding trade, these sectors benefit from the tariff-elimination-induced demand for imports which leads to a stimulation of exports. The strongest effect of the tariff elimination generally occurs in the foreign trade flows of Ukraine. At the same time the fundamental trade structure remains almost unchanged.

Most previous studies on trade liberalization of Ukraine do not explicitly state how liberalization cost compensation is modeled. Moreover, the results differ significantly. Pavel et al. (2004), Jensen et al. (2005), Harbuzyuk and Lutz (2008), Maliszewska et al. (2009), Ecorys and CASE-Ukraine (2007) predict positive welfare effects (3-5%) whereas unchanged or even slightly lower welfare levels for Ukraine are found by Emerson et al. (2006), Francois and Manchin (2009). Our analysis suggests that one possible reason for the diverging results consists in different assumptions about the endogenous fiscal adjustments after trade liberalization. According to our simulations, negative as well as positive welfare effects can result depending on the scenario. Though, our results differ in terms of magnitude from those found in the previous literature probably because most of the studies mentioned above use data on import tariffs applied *before* Ukraine's WTO accession. This suggests that the elimination of already reduced tariff rates *after* Ukraine's WTO accession generates no or only slightly positive welfare gains because of the initially low level of protection.

Our study shows that the results are quite sensitive with respect to changes in fiscal policy. In particular, in our simulation the positive effects of the tariff elimination are more than outweighed by the negative effects from the endogenous increase in indirect taxes. This highlights the fact that the government should be prudent in funding the

liberalization costs by means of an increase in tax rates.

Although we focus only on the effects of a simple EU-Ukraine FTA, the contracting parties are in fact negotiating a DCFTA. This would imply even higher costs of trade liberalization for Ukraine and the question of how to deal with this problem would be even more important. Compensating these costs with foreign aid, as assumed in our scenario 3, would enable Ukraine to gain even higher positive welfare effects as a result of a DCFTA with the EU.

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Appendix

Table A.1: **Countries' aggregation into trading regions**

Region	Country	Region	Country
1. EU-15		**5. Asia**	
	Austria		China
	Belgium		India
	Denmark		Indonesia
	Finland		Iran
	France		Israel
	Germany		Japan
	Greece		Lebanon
	Ireland		South Korea
	Italy		Syria
	Luxembourg		Turkey
	Netherlands		United Arab Emirates
	Portugal		Vietnam
	Spain		Jordan
	Sweden		Malaysia
	UK		Pakistan
			Singapore
			Thailand
			Saudi Arabia
2. EU-12		**6. Africa**	
	Estonia		Algeria
	Latvia		Egypt
	Lithuania		Tunisia
	Czech Republic		Libya
	Hungary		Ghana
	Poland		Maorocco
	Slovakia		Nigeria
	Slovenia		
	Cyprus		
	Malta		
	Bulgaria		
	Romania		
3. Other Europe		**7. America**	
	Bosnia and Herzegovina		Argentina
	Croatia		Brazil
	Macedonia		Canada
	Serbia		USA
	Switzerland		Mexico
	Norway		Br. Virgin Islands
	Albania		
4. CIS		**8. Russia**	
	Armenia		Russian Federation
	Azerbaijan		
	Belarus	**9. Rest of the world**	
	Georgia		All other countries
	Kazakhstan		
	Kyrgyzstan		
	Moldova		
	Tajikistan		
	Tuekmenistan		
	Uzbekistan		

Table A.2: **Initial input and output structure of production sectors**

Sector		Input (in %)							Output (in %)		
		Intermediate demand	Capital demand	Sector-specific capital demand	Skilled labor demand	Unskilled labor demand	Depreciation	Total	Domestic sales	Exports	Total
a01	Agriculture	58,23	31,63	0,00	3,55	5,68	0,92	100	92,45	7,55	100
a02	Forestry	39,34	7,27	0,00	27,10	26,28	0,00	100	67,63	32,37	100
a03	Fishing	72,08	9,94	0,00	8,22	9,76	0,00	100	97,22	2,78	100
a04	Mining of coal and peat	38,85	0,00	15,98	25,71	19,27	0,18	100	93,48	6,52	100
a05	Production of hydrocarbons	25,24	46,57	0,00	16,11	12,08	0,00	100	92,99	7,01	100
a06	Mining and quarrying	51,85	27,40	0,00	10,62	7,96	2,16	100	73,09	26,91	100
a07	Food-processing	73,86	10,95	0,00	7,35	5,51	2,34	100	78,33	21,67	100
a08	Textile industry	47,51	20,68	0,00	12,07	9,05	10,69	100	28,80	71,20	100
a09	Wood industry	73,36	9,03	0,00	10,07	7,54	0,00	100	71,20	28,80	100
a10	Manufacture of coke products	77,11	13,87	0,00	4,00	3,00	2,02	100	95,79	4,21	100
a11	Petroleum refinement	87,90	4,46	0,00	4,37	3,27	0,00	100	78,97	21,03	100
a12	Chemical industry	78,83	9,92	0,00	6,43	4,82	0,00	100	46,33	53,67	100
a13	Other non-metallic products	71,04	11,06	0,00	10,23	7,67	0,00	100	91,39	8,61	100
a14	Metallurgy, metal processing	77,76	8,55	0,00	7,61	5,71	0,36	100	39,24	60,76	100
a15	Machine building	73,47	9,43	0,00	9,77	7,32	0,00	100	55,08	44,92	100
a16	Other production	70,34	6,69	0,00	10,27	7,70	4,99	100	76,60	23,40	100
a17	Electric energy, heat supply	64,04	15,02	0,00	13,72	7,22	0,00	100	95,91	4,09	100
a18	Gas supply	45,76	9,08	0,00	29,59	15,57	0,00	100	99,93	0,07	100
a20	Water supply	60,50	0,68	0,00	25,43	13,39	0,00	100	99,61	0,39	100
a21	Construction	68,41	8,89	0,00	11,67	11,04	0,00	100	99,22	0,78	100
a22	Trade and repair activities	72,46	17,46	0,00	7,07	3,01	0,00	100	99,65	0,35	100
a23	Hotels and restaurants	55,74	26,38	0,00	11,21	6,67	0,00	100	49,08	50,92	100
a24	Transport	56,25	18,11	0,00	13,73	11,91	0,00	100	96,23	3,77	100
a25	Post and telecommunications	47,58	30,69	0,00	14,08	7,65	0,00	100	90,10	9,90	100
a26	Financial activities	31,18	36,05	0,00	29,96	2,81	0,00	100	96,10	3,90	100
a27	Real estate activities	42,89	42,22	0,00	10,20	4,69	0,00	100	97,15	2,85	100
a28	Renting	36,76	51,16	0,00	8,28	3,81	0,00	100	91,90	8,10	100
a29	Computer and related activities	53,43	23,93	0,00	15,51	7,13	0,00	100	84,67	15,33	100
a30	Research and development	22,43	9,26	0,00	53,82	8,18	6,32	100	79,97	20,03	100
a31	Other business activities	51,90	18,89	0,00	20,01	9,20	0,00	100	93,41	6,59	100
a32	Public administration	26,09	3,84	0,00	64,17	5,90	0,00	100	99,77	0,23	100
a33	Education	26,91	7,25	0,00	54,39	11,46	0,00	100	99,46	0,54	100
a34	Health care and social assistance	35,73	8,37	0,00	42,73	13,17	0,00	100	98,59	1,41	100
a35	Streets cleaning, other utilities	55,59	7,38	0,00	20,22	16,81	0,00	100	99,50	0,50	100
a36	Social activities	46,27	0,71	0,00	28,96	24,07	0,00	100	100,00	0,00	100
a37	Leisure activities	51,07	15,93	0,00	26,53	6,47	0,00	100	89,84	10,16	100
a38	Other activities	34,24	45,17	0,00	16,56	4,03	0,00	100	87,52	12,48	100
a24P	Pipeline transit	81,24	0,00	9,93	4,73	4,10	0,00	100	0,00	100,00	100

Table A.3: **Factor intensity of production sectors**

Sector		Capital demand (%)	Labor demand (%)	Factor intensity*
a01	Agriculture	70,1	29,9	capital
a02	Forestry	21,9	78,1	labor
a03	Fishing	44,0	55,9	labor
a04	Mining of coal and peat	30,7	69,4	labor
a05	Production of hydrocarbons	59,5	40,5	capital
a06	Mining and quarrying	53,6	46,4	capital
a07	Food-processing	54,1	45,9	capital
a08	Textile industry	50,7	49,3	capital
a09	Wood industry	38,6	61,4	labor
a10	Manufacture of coke products	40,4	59,6	labor
a11	Petroleum refinement	55,1	44,9	capital
a12	Chemical industry	48,9	51,1	labor
a13	Other non-metallic products	44,9	55,1	labor
a14	Metallurgy, metal processing	44,2	55,8	labor
a15	Machine building	41,4	58,7	labor
a16	Other production	38,0	62,0	labor
a17	Electric energy, heat supply	42,6	57,4	labor
a18	Gas supply	31,5	68,5	labor
a20	Water supply	24,8	75,2	labor
a21	Construction	39,6	60,4	labor
a22	Trade and repair activities	58,1	41,9	capital
a23	Hotels and restaurants	56,0	44,0	capital
a24	Transport	46,1	53,9	labor
a25	Post and telecommunications	54,8	45,2	capital
a26	Financial activities	51,4	48,6	capital
a27	Real estate activities	63,7	36,3	capital
a28	Renting	72,2	27,8	capital
a29	Computer and related activities	48,5	51,5	labor
a30	Research and development	19,2	80,8	labor
a31	Other business activities	42,6	57,4	labor
a32	Public administration	13,8	86,2	labor
a33	Education	17,2	82,8	labor
a34	Health care and social assistance	23,3	76,7	labor
a35	Streets cleaning, other utilities	29,1	70,9	labor
a36	Social activities	23,2	76,8	labor
a37	Leisure activities	36,6	63,4	labor
a38	Other activities	62,7	37,3	capital
a24P	Pipeline transit	46,1	53,9	labor

* The calculation of factor intensity for the model specific sectors accounts also for factor intensity of intermediate products (up to three stages).

Table A.4: **Consumption shares (in %)**

Sector		Consumer				
		Households				Government
		urban	rural	urban poor	rural poor	
a01	Agriculture	10,54	9,19	12,90	7,98	0,90
a02	Forestry	0,09	0,64	0,24	0,62	0,22
a03	Fishing	1,67	1,64	1,73	1,28	0,00
a04	Mining of coal and peat	0,09	0,64	0,24	0,62	0,17
a05	Production of hydrocarbons	0,50	1,45	0,34	1,29	0,75
a06	Mining and quarrying	0,00	0,00	0,00	0,00	0,00
a07	Food-processing	40,97	42,36	48,78	36,49	0,28
a08	Textile industry	7,23	7,72	6,58	6,20	0,32
a09	Wood industry	0,54	0,44	0,50	0,31	0,03
a10	Manufacture of coke products	0,09	0,64	0,24	0,62	0,00
a11	Petroleum refinement	0,41	0,59	0,12	0,23	0,02
a12	Chemical industry	2,49	3,29	2,24	1,87	0,10
a13	Other non-metallic products	0,64	1,07	0,24	0,30	0,00
a14	Metallurgy, metal processing	0,62	1,06	0,22	0,28	0,00
a15	Machine building	3,40	4,31	1,17	1,17	0,46
a16	Other production	1,47	2,24	0,69	1,31	0,02
a17	Electric energy, heat supply	4,31	1,71	5,94	1,96	1,68
a18	Gas supply	1,53	2,51	3,70	2,18	0,12
a20	Water supply	0,66	0,24	1,25	0,31	0,25
a21	Construction	1,55	1,84	0,28	0,34	0,00
a22	Trade and repair activities	0,44	0,70	0,11	0,10	0,01
a23	Hotels and restaurants	2,66	1,24	1,07	0,56	0,20
a24	Transport	1,71	1,11	1,36	0,56	3,18
a25	Post and telecommunications	2,75	1,67	2,56	1,01	0,17
a26	Financial activities	5,70	7,84	1,90	2,96	0,00
a27	Real estate activities	1,36	0,23	1,34	0,05	1,93
a28	Renting	1,39	0,08	0,80	0,06	0,00
a29	Computer and related activities	0,00	0,00	0,00	0,00	0,01
a30	Research and development	0,00	0,00	0,00	0,00	2,63
a31	Other business activities	0,00	0,00	0,00	0,00	0,11
a32	Public administration	0,00	0,00	0,00	0,00	31,08
a33	Education	1,61	0,93	1,18	0,47	29,31
a34	Health care and social assistance	1,23	1,61	0,99	0,78	22,44
a35	Streets cleaning, other utilities	0,40	0,03	0,66	27,64	0,92
a36	Social activities	0,00	0,00	0,00	0,00	0,00
a37	Leisure activities	1,04	0,22	0,23	0,11	2,68
a38	Other activities	0,90	0,76	0,42	0,32	0,01
Total		100	100	100	100	100

Table A.5: **Disaggregate results**

Sector	Changes relative to benchmark (in %)								
	Output			Exports			Imports		
	S1	S2	S3	S1	S2	S3	S1	S2	S3
a01 Agriculture	-1.19	-1.34	-1.04	-0.78	-0.78	-0.47	6.62	6.28	6.59
a02 Forestry	0.22	0.14	-0.08	0.32	0.07	-0.47	2.70	2.99	3.39
a03 Fishing	-0.87	-1.22	-0.97	-0.09	-0.48	-0.41	0.33	0.02	0.47
a04 Mining of coal and peat	0.87	0.49	0.24	0.43	0.05	-0.19	1.37	1.00	0.73
a05 Production of hydrocarbons	0.04	0.13	-0.32	-0.34	0.38	-0.72	0.45	-0.13	0.12
a06 Mining and quarrying	1.68	1.25	0.58	2.13	1.83	0.92	1.50	0.86	0.59
a07 Food-processing	-1.94	-2.49	-1.94	-0.89	-1.32	-0.99	13.45	12.58	13.64
a08 Textile industry	1.52	2.85	0.74	3.56	5.24	2.62	3.11	2.48	3.25
a09 Wood industry	0.86	0.47	0.44	2.46	1.99	1.75	0.31	0.06	0.38
a10 Manufacture of coke products	1.70	1.17	0.57	1.58	1.11	0.45	2.74	2.15	1.62
a11 Petroleum refinement	-0.30	-1.15	-0.48	-0.17	-1.52	-0.42	0.98	0.91	0.92
a12 Chemical industry	2.96	2.80	2.39	5.68	5.53	4.94	1.60	1.37	1.54
a13 Other non-metallic products	-1.69	-1.95	-1.97	-0.78	-1.11	-1.29	9.31	9.10	9.28
a14 Metallurgy, metal processing	2.09	1.47	0.77	2.83	2.11	1.25	1.32	1.11	1.03
a15 Machine building	0.37	0.09	-0.32	2.20	1.94	1.21	1.36	1.01	1.41
a16 Other production	0.76	0.49	0.40	2.33	1.90	1.64	1.27	1.27	1.42
a17 Electric energy, heat supply	0.41	0.21	0.20	0.42	0.12	0.00	0.39	0.30	0.42
a18 Gas supply	0.44	0.19	0.16	0.74	0.24	-0.06	0.14	0.14	0.39
a20 Water supply	-0.01	-0.10	0.11	0.29	-0.58	-0.17	-0.30	0.40	0.38
a21 Construction	0.37	0.21	0.40	1.44	1.10	1.19	-0.70	-0.69	-0.39
a22 Trade and repair activities	0.39	-0.02	0.23	0.32	0.18	0.04	0.42	-0.26	0.38
a23 Hotels and restaurants	1.16	0.83	1.05	1.72	1.34	1.50	-0.55	-0.75	-0.33
a24 Transport	0.22	-0.03	0.09	0.22	-0.03	-0.09	0.12	-0.05	0.20
a25 Post and telecommunications	0.19	0.16	0.23	0.64	1.00	0.56	-0.36	-0.87	-0.17
a26 Financial activities	0.18	0.04	-0.03	0.03	0.13	-0.57	0.33	-0.06	0.56
a27 Real estate activities	0.06	0.10	0.16	-0.01	0.12	0.08	0.14	0.08	0.26
a28 Renting	0.15	0.14	0.05	-0.28	0.42	-0.26	0.67	-0.19	0.42
a29 Computer and related activities	0.34	0.28	0.36	0.90	0.87	0.68	-0.42	-0.52	-0.09
a30 Research and development	-0.50	0.17	0.11	0.41	0.28	0.07	-1.85	0.01	0.18
a31 Other business activities	0.29	0.03	0.09	0.66	0.43	0.10	-0.13	-0.42	0.08
a32 Public administration	-1.62	-0.04	-0.07	-0.86	-0.60	-0.47	-2.36	0.53	0.34
a33 Education	-1.60	-0.11	-0.05	-1.10	-0.81	-0.52	-2.10	0.60	0.43
a34 Health care and social assistance	-1.45	0.04	0.12	-0.37	0.05	0.47	-2.54	0.03	-0.24
a35 Streets cleaning, other utilities*	-0.60	-0.04	0.06	-0.17	-0.46	0.07	-1.02	0.38	0.05
a36 Social activities	0.13	-0.12	0.09						
a37 Leisure activities*	-0.69	-0.17	-0.08	-0.50	-0.36	-0.46	-0.92	0.07	0.38
a38 Other activities	0.20	0.02	0.21	0.34	0.16	0.29	0.01	-0.17	0.11
a24P Pipeline transit	0.30	-0.03	0.03	0.30	-0.03	0.03			
		strong negative changes				strong positive changes			

*a35: sewage, refuse disposal; a37 includes recreational, entertainment, cultural and sporting activities.

Table A.6: **Sector-specific results**

Sector		Changes relative to benchmark (in %)											
		Capital demand			Skilled labor demand			Unskilled labour demand			Intermediate demand		
		S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
a01	Agriculture	-1.23	-1.31	-1.02	-0.83	-1.46	-1.11	-1.21	-1.45	-1.09	-1.19	-1.34	-1.04
a02	Forestry	0.03	0.27	-0.01	0.44	0.12	-0.10	0.04	0.13	-0.08	0.22	0.14	-0.08
a03	Fishing	-1.00	-1.12	-0.92	-0.59	-1.28	-1.01	-0.98	-1.27	-0.98	-0.87	-1.22	-0.97
a04	Mining of coal and peat				1.36	0.66	0.32	0.96	0.67	0.34	0.87	0.49	0.24
a05	Production of hydrocarbons	-0.05	0.19	-0.29	0.35	0.03	-0.38	-0.04	0.04	-0.36	0.04	0.13	-0.32
a06	Mining and quarrying	1.58	1.32	0.62	2.00	1.16	0.53	1.60	1.17	0.55	1.68	1.25	0.58
a07	Food-processing	-2.07	-2.41	-1.90	-1.67	-2.57	-1.99	-2.06	-2.56	-1.96	-1.94	-2.49	-1.94
a08	Textile industry	1.40	2.93	0.78	1.81	2.77	0.69	1.41	2.78	0.72	1.52	2.85	0.74
a09	Wood industry	0.71	0.57	0.49	1.11	0.42	0.40	0.72	0.43	0.42	0.86	0.47	0.44
a10	Manufacture of coke products	1.62	1.22	0.60	2.03	1.06	0.51	1.63	1.07	0.53	1.70	1.17	0.57
a11	Petroleum refinement	-0.45	-1.05	-0.43	-0.05	-1.21	-0.52	-0.44	-1.20	-0.49	-0.30	-1.15	-0.48
a12	Chemical industry	2.83	2.88	2.44	3.25	2.72	2.34	2.85	2.73	2.37	2.96	2.80	2.39
a13	Other non-metallic products	-1.83	-1.86	-1.92	-1.43	-2.01	-2.01	-1.82	-2.00	-1.98	-1.69	-1.95	-1.97
a14	Metallurgy, metal processing	1.94	1.56	0.82	2.35	1.41	0.73	1.95	1.42	0.75	2.09	1.47	0.77
a15	Machine building	0.22	0.19	-0.27	0.63	0.03	-0.36	0.23	0.04	-0.33	0.37	0.09	-0.32
a16	Other production	0.58	0.61	0.45	0.99	0.45	0.36	0.60	0.46	0.39	0.76	0.49	0.40
a17	Electric energy, heat supply	0.25	0.29	0.25	0.65	0.14	0.16	0.26	0.15	0.18	0.41	0.21	0.20
a18	Gas supply	0.21	0.32	0.23	0.62	0.16	0.14	0.23	0.17	0.16	0.44	0.19	0.16
a20	Water supply	-0.27	0.05	0.19	0.13	-0.10	0.10	-0.26	-0.09	0.12	-0.01	-0.10	0.11
a21	Construction	0.22	0.32	0.46	0.63	0.16	0.37	0.23	0.17	0.39	0.37	0.21	0.40
a22	Trade and repair activities	0.29	0.04	0.26	0.69	-0.12	0.17	0.30	-0.11	0.19	0.39	-0.02	0.23
a23	Hotels and restaurants	1.06	0.89	1.08	1.47	0.73	0.99	1.07	0.74	1.02	1.16	0.83	1.05
a24	Transport	0.09	0.06	0.14	0.49	-0.09	0.05	0.10	-0.09	0.07	0.22	-0.03	0.09
a25	Post and telecommunications	0.08	0.22	0.27	0.49	0.06	0.18	0.09	0.07	0.20	0.19	0.16	0.23
a26	Financial activities	0.00	0.12	0.01	0.41	-0.04	-0.08	0.01	-0.03	-0.05	0.18	0.04	-0.03
a27	Real estate activities	-0.01	0.14	0.19	0.40	-0.02	0.10	0.00	-0.01	0.12	0.06	0.10	0.16
a28	Renting	0.10	0.17	0.07	0.51	0.01	-0.02	0.11	0.02	0.00	0.15	0.14	0.05
a29	Computer and related activities	0.20	0.35	0.40	0.61	0.19	0.31	0.21	0.20	0.33	0.34	0.28	0.36
a30	Research and development	-0.81	0.30	0.19	-0.40	0.15	0.10	-0.79	0.16	0.12	-0.50	0.17	0.11
a31	Other business activities	0.12	0.12	0.14	0.53	-0.03	0.05	0.13	-0.02	0.07	0.29	0.03	0.09
a32	Public administration	-1.96	0.11	0.02	-1.56	-0.05	-0.07	-1.95	-0.04	-0.05	-1.62	-0.04	-0.07
a33	Education	-1.90	0.03	0.03	-1.50	-0.13	-0.06	-1.89	-0.12	-0.04	-1.60	-0.11	-0.05
a34	Health care and social assistance	-1.71	0.17	0.19	-1.31	0.02	0.10	-1.70	0.03	0.13	-1.45	0.04	0.12
a35	Streets cleaning, other utilities*	-0.78	0.08	0.13	-0.38	-0.07	0.04	-0.77	-0.06	0.06	-0.60	-0.04	0.06
a36	Social activities	-0.09	0.03	0.17	0.31	-0.13	0.08	-0.08	-0.12	0.10	0.13	-0.12	0.09
a37	Leisure activities*	-0.91	-0.06	-0.02	-0.50	-0.22	-0.11	-0.89	-0.21	-0.09	-0.69	-0.17	-0.08
a38	Other activities	0.09	0.06	0.24	0.50	-0.09	0.15	0.11	-0.08	0.17	0.20	0.02	0.21
a24P	Pipeline transit				0.83	-0.08	0.06	0.43	-0.07	0.08	0.30	-0.03	0.03

Table A.7: **Public spending (UAH bn)**

Sector		Benchmark	Changes		
		S0	S1	S2	S3
b01	Agriculture	1.1630	-0.0224	0.0032	0.0024
b02	Forestry	0.2800	-0.0057	0.0003	-0.0002
b03	Fishing	0.0000	0.0000	0.0000	0.0000
b04	Mining of coal and peat	0.1849	-0.0039	-0.0012	-0.0001
b05	Production of hydrocarbons	0.7818	-0.0163	-0.0059	0.0001
b06	Mining and quarrying	0.0000	0.0000	0.0000	0.0000
b07	Food-processing	0.3128	-0.0050	0.0000	0.0016
b08	Textile industry	0.3700	-0.0030	0.0038	0.0048
b09	Wood industry	0.0360	-0.0006	0.0000	0.0001
b10	Manufacture of coke products	0.0000	0.0000	0.0000	0.0000
b11	Petroleum refinement	0.0220	-0.0004	-0.0001	0.0000
b12	Chemical industry	0.1179	-0.0011	0.0010	0.0014
b13	Other non-metallic products	0.0030	0.0000	0.0000	0.0000
b14	Metallurgy. metal processing	0.0050	-0.0001	0.0000	0.0000
b15	Machine building	0.5338	-0.0068	0.0025	0.0043
b16	Other production	0.0190	-0.0003	0.0000	0.0001
b17	Electric energy. heat supply	1.7160	-0.0355	-0.0142	-0.0002
b18	Gas supply	0.1250	-0.0025	-0.0007	0.0000
b20	Water supply	0.2660	-0.0054	-0.0019	-0.0001
b21	Construction	0.0000	0.0000	0.0000	0.0000
b22	Trade and repair activities	0.0170	-0.0004	-0.0001	0.0000
b23	Hotels and restaurants	0.2430	-0.0047	-0.0003	0.0003
b24	Transport	4.0790	-0.0845	0.0033	0.0000
b25	Post and telecommunications	0.2090	-0.0041	0.0002	0.0002
b26	Financial activities	0.0000	0.0000	0.0000	0.0000
b27	Real estate activities	2.4060	-0.0502	-0.0008	0.0003
b28	Renting	0.0000	0.0000	0.0000	0.0000
b29	Computer and related activities	0.0090	-0.0002	0.0000	0.0000
b30	Research and development	3.3970	-0.0636	0.0042	0.0006
b31	Other business activities	0.1380	-0.0028	0.0002	0.0000
b32	Public administration	40.0770	-0.7725	-0.0039	-0.0198
b33	Education	37.8030	-0.7456	-0.0158	-0.0250
b34	Health care and social assistance	28.9320	-0.5374	0.0294	0.0289
b35	Streets cleaning. other utilities	1.1880	-0.0236	0.0001	0.0004
b36	Social activities	0.0000	0.0000	0.0000	0.0000
b37	Leisure activities	3.4470	-0.0702	0.0020	-0.0015
b38	Other activities	0.0130	-0.0003	0.0000	0.0000
b24P	Pipeline transit	0.0000	0.0000	0.0000	0.0000