COAL PRODUCTION SUBSIDIES ELIMINATION IN UKRAINE: A CGE ANALYSIS[1]

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Abstract

Despite intensive development and implementation of government programs and sector-specific energy policies together with consideration of subsidies elimination as a strategic coal industry priority, governmental grants volumes for this economic activity are growing from year to year. While in 2003 Government cost covering support for coal industry equaled to 0,9 bn UAH, in 2013 Ukrainian Government transferred over 13,3 bn UAH, which is a crippling burden for National Budget. And although coal subsidies elimination process can be considered as a highly complicated and painful, due to resulting social issues, current economic situation even more escalates its necessity. In this paper a computable general equilibrium (CGE) model is applied to study the consequences and economic effects of coal subsidies elimination in Ukraine.

Key words: coal production subsidies, reform, Ukraine, CGE model, GTAP.

JEL classification: D58, Q43, Q48.

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Introduction

Despite intensive development and implementation of government programs and sector-specific energy policies together with consideration of subsidies elimination as a strategic coal industry priority, governmental grants volumes for this economic activity are growing from year to year. While in 2003 State cost covering support for coal industry equaled to 0,9 bn UAH, in 2013 Ukrainian Government transferred over 13,3 bn UAH, which is a crippling burden for National Budget. Such situation is caused by the fact that almost all state-owned coal mines are highly lossmaking due to the wide variety of issue. They include difficult mining conditions, highly depleted capital stock and overall low technological level, poor quality of coal, which sulphur content is 2-3 times higher than world average, inefficient administration, etc. As a result, while average price for extracted in 2013 coal was 493,1 UAH/ton, real production costs for state enterprises were almost 3-times higher – 1352,7 UAH/ton. At the same time, most of the economically attractive coal mines are already in the private property, concession or long-term lease. In such circumstances, an obvious option is to suspend or close all economically irrational mines. But issue is rather complicated, as long as this process has to take into consideration both social (particularly labor force) and economic (incl. coal import increase) effects.

In this paper we adopt a CGE model to investigate diversified economic and social effects that arise due to the partial or full elimination of coal production subsidies. In order to define the most beneficial compensatory policy options this article focuses on various ways of saved money allocation. In addition, policy options are analyzed under different closure rules.

Literature review

Coal subsidies elimination analysis via CGE framework has been conducted for a several regions, mainly in the context of broad issues of fossil fuel tariff reform or environmental policy investigation. In addition, as long as coal

production subsidies are not widely adopted in the world, as compared to the consumer subsidies, there are not so many papers that examine this issue, either using economic modelling or other approaches. Substantial part of these articles refers to the coal reform in Western Europe and some Asian countries.

Anderson and McKibbin (1997) used a dynamic CGE model of the global economy (C-Cubed) to examine the economic and environmental effects of coal subsidies removal. Authors suggest that elimination of production and consumption coal subsidies in OECD and developing countries could lower global CO_2 emission by 8% (relative to the baseline). At the same time, Western European countries, as net importers of coal, turn their terms of trade against themselves when they reform, which benefits Australia and the coal-exporting transition economies of Eastern Europe and China and harms net coal-importing developing countries. As a result an annual GDP decrease for this group of countries lies between 0,1% and 0,3%.

O'Ryan et al. (2003) investigated the consequences of coal production subsidies elimination in Chile applying static CGE model ECOGEM-Chile. As long as such policy option could result in severe employment effects for coal industry workers, authors studied two scenarios. The first one included compensatory transfers to households, while the second one did not consider any change in public spending and all additional funds were spent on government savings increase. As authors conclude, the overall macroeconomic effects of eliminating coal subsidies are very small. And when savings are used to increase transfers to households, the effects are even lower. The removal of the coal subsidy has a slightly positive impact on income distribution when transfers are used to compensate households. When there is no increase in public spending, income for all groups falls slightly, approximately by 0,1%. After subsidies elimination, coal production falls by around one half solely (-43%), electricity sector decreases by 0,5%. Construction and hydraulic sectors benefit the most, their output growth by 0,1%-0,4%, depending on the scenario.

A number of studies used another approaches (apart form CGE) to estimate the effects of coal production subsidies reform. For example, Radezki (1995) applied a Marginal cost curve approach to investigate the coal subsidies elimination effect on production and import volumes. This policy was examined for four West European countries, namely France, Germany, Spain and UK. As results show, in the medium term subsidies elimination would result in the average 60% decline in coal production, varying between countries form 100% (Spain) to 35% (UK). In the long run aggregate output decrease is even more severe and reaches 70%.

Ukrainian coal industry

Considering 2013 data, Ukrainian hard coal industry includes 82 state and 53 private mines (Shevchenko and Vorobjov, 2014). During this period government-owned enterprises produced 24,1 million tons (Mt) of coal, while private mines extracted 60,2 Mt. In general, domestic coal market can be divided into two key segments: steam coal, which is used primarily for energy generation and coking coal that is utilized mainly for steel production. Ukrainian hard coal market is characterized by a deficit of the coking coal, by an excess supply of the steam coal of anthracite group and by the deficit of Grade T lean coals demanded by the power sector (Baker Tilly, 2013). In 2013 Ukraine imported over 14 Mt of coking coal (10,2 Mt from Russia), which can not be even theoretically substituted by Ukrainian coal as long as it has different properties (SSSU, 2014).

On the supply side Ukrainian coal market is defined by the domination of private vertically-integrated companies. The biggest one is SKM Holding, which includes among others Metinvest group – performs full production cycle form extraction of coal and ore to manufacturing of rolled products and pipes. In 2013 this company extracted over 11 Mt of coking coal. Another powerful structural unit of SKM is DTEK – the biggest Ukrainian energy company, which includes 2 heat power plants, 10 thermoelectric power stations, 31 coal mines (including mines in USA and Russia) and 13 coal preparation plants. DTEK’s coal extraction in 2013

reached 41,4 Mt. Second huge vertically-integrated company is Donetsksteel with the largest Ukrainian coal company "Pokrovske" – annual coal extraction over 8,5 Mt.

Government sector of the coal industry consists of the 18 unitary state enterprises (SE), each of them includes from 1 to 9 mines; 3 coal mining stock companies; and separate group of technically independent coal mines that have to be closed but temporarily continue occasional coal production (Amosha, Starychenko and Cherevatskyj, 2013). Almost all coal SE receive subsidies from the Government budget that compensate the difference between production costs and market price of the extracted coal. In 2013 such subsidies amounted to more than 13,3 bn UAH or 3,4% of Government budget (MECIU, 2014).

Due to the number of factors, namely difficult mining conditions, highly depleted capital stock and overall low technological level, poor quality of coal, inefficient administration and huge investments deficit, state-owned mines perform substantially less efficient than private enterprises (*Table 1*).

Table 1. Comparison of state and private coal sectors in Ukraine

Indicators	*State sector*					*Private sector*				
	2005	*2010*	*2011*	*2012*	*2013*	*2005*	*2010*	*2011*	*2012*	*2013*
Number of coal mines	145	120	111	99	82	29	32	37	49	53
Coal production, Mt	46,1	38,4	38,4	24,8	24,1	31,9	36,8	43,6	61,3	59,6
Average daily load, t/mine	885	890	960	980	1150*	3580	3990	3850	4100	3723*
Labor productivity, t/month	22,4	21,5	23,5	19,2	19,1	45,8	55,0	60,1	-	-
Average salary, UAH/month	1161	3736	4656	5350	5600	1692	5260	6326	6990	7220
Price/production cost of coal marketed output, UAH/t	219 /274	551 /851	630 /989	544 /1212	492 /1348	221 /179	544 /472	-	-	-
State support of coal producers, bn UAH, incl.	1,8	6,9	9,4	14,0	14,9	0	0	0	0	0
cost covering support	0,9	5,8	6,7	9,9	13,3	0	0	0	0	0
capital expenditures, technical renovation and restructuring	0,9	1,1	2,7	4,1	1,6	0	0	0	0	0

Source: Shevchenko and Vorobjov (2014), MECIU (2014).
* author estimates;
- no data available.

And although for more than 10 years Government was developing and partially implementing programs aimed at closure and conservation of marginal mines together with cost support decrease, these attempts did not lead to success. Moreover, aggregate nominal state support has grown by more than 8 times during

the last 8 years, while cost covering support in 2013 was 15 times larger than in 2005. During these 10 years the most profitable and commercially viable mines were privatized, taken into concession or long-term lease. As a result, the most unprofitable mines remained in public ownership. This is can be clearly seen from the price/production cost rate evolution in Table 1. In 2005 production costs were only 25% higher than market price, but in 2013 the difference was more than 174%. Furthermore, this process was accompanied by moderate 14% decrease in labor productivity in the state sector, mostly due to the average worsening of mining conditions. The opposite process can be observed for the private coal sector, where labor productivity was rapidly growing since 2005.

Clearly it was not just bad administration that substantially blunted the efficiency of coal sector reform undertakings. There are number of internal and external issues that essentially complicate the situation. One of them is labor force/unemployment problem. Ukrainian hard coal sector has over 170 000 engaged people and over 80% of then are employed on the state mines. Moreover, in some cases public coal mine could be a principal employer and mainstay of an entire residential area. In this case, it is almost impossible to close the enterprise without considering severe employment effects.

Other important issues are related to trade balance and energy security level shifts. In particular, rapid subsidies elimination could not only substantially increase trade deficit, but also adversely influence energy security if coal import volumes would not be diversified and Ukraine could become even more energy dependent.

On the other hand, although coal subsidies elimination process can be considered as highly complicated and painful, due to resulting negative issues, current economic situation even more escalates its necessity.

Modelling framework

To estimate the effects of coal production subsidies elimination in Ukraine and analyze alternative compensation policies this study adopts a standard Global

trade analysis project (GTAP) modelling framework, which is documented in https://www.gtap.agecon.purdue.edu/. It is a static multi-regional, multi-sectoral CGE model, with perfect competition and constant returns to scale. Model has separate treatment for each regional economy, which in turn is represented by several economic agents.

In GTAP model each region's final demand structure is portrayed by a representative agent who allocates expenditure between goods in order to maximize welfare. Producers employ capital, skilled and unskilled labor, land and intermediate goods to supply commodities. Production volumes are defined within cost-minimization problem. Domestically produced and imported goods are treated as imperfect substitutes and represented via Armington aggregate. In addition industrial and residential users differentiate commodity by its region of origin, same goods from different countries are also represented as imperfect substitutes. To represent the international trade flows GTAP database includes the full set of bilateral currents of trade with associated transport costs, export tariffs and taxes.

Model equilibrium is defined via standard set of conditions, namely zero profit, market clearance and income balance. Once initial values of exogenous parameters are changed, equilibrium conditions are violated and new model steady state has to be found. Investigated policy options effects would be defined by the difference between new and initial equilibrium values.

Data

Ukrainian coal production subsidies elimination study is based on the data derived form GTAP 8 database with the benchmark year 2007. In our analysis we employ regional and sectoral aggregated data. In particular, it includes 6 regions (Ukraine, USA, EU-27, Russia, China and the Rest of the world) and 16 sectors. Coal industry is united with forestry and fishing ("Other extraction" sector). As long as these two sectors are comparatively small and do not receive any production subsidies, such aggregation would not significantly influence the results. At the same time, considering that Ukraine is developing country with

rapid structural changes and high differentiation between growth rates for different industries, 2007 benchmark data may not be beneficial for the coal subsidies elimination study. To solve this issue we verified some tax and subsidy rates considering the latest available data. Although the latest Ukrainian Input-output table (IOT) is based on the 2012 statistics, we applied 2011 IO data. Main reason for such a decision was sectoral aggregation issue: 2012 IOT has single sector that represents the extraction industry, including coal, oil, natural gas and metal ores production, which is not suitable for the conducted analysis. At the same time 2011 IOT has three distinct extraction sectors with separate treatment of coal, lignite and uranium ores production. According to the comparative analysis, based on the available 2007 and 2011 IOTs for Ukraine, actual subsidization rate for the industry under investigation has not changed significantly. At the same time its 2007 IOT's value slightly differs from the corresponding number presented in the GTAP database, probably due to some aggregation and representation differences.

Scenarios and simulation results

Several policy options were investigated in this study. *Firstly*, we estimated economic effects for 50% and 100% coal production subsidies elimination in the "Other extraction" sector. In the standard GTAP closure it is assumed that Government expenditures are variable, so this policy should result in State income and spending increase.

At the same time, even full subsidies elimination in the context of GTAP framework (setting "Other extraction" sector tax rate to "0") is not equivalent to the actual policy shock. In the GTAP database production subsidies and taxes are not distinguished, but they are added. Considering this fact if we would take actual subsidies rate for the aforementioned sector it would be equaled to 11,6%, which is almost twice higher than benchmark subsidization rate. So *second* investigated policy option includes setting production tax rate equaled to 3,4%. This value corresponds to the full elimination of existing coal production subsidies and preservation of current tax rates.

Another issue concerns the fact that investigated policy option would lead to the severe effects for the State coal mines employees and they would face significant welfare decrease. In this context we investigate an option of fixed ratio of indirect tax revenue to national income. In this case coal production subsidies elimination (production tax increase) is compensated by corresponding sales tax on private commodity consumption decline.

Finally, this study investigates labor market effects under alternative closure options. Namely they include either fixed real labor price and variable labor supply or vise versa. As long as subsidization policy would sufficiently influence trade flows it is advantageous to study economic performance under different assumptions concerning either fixed trade balance or constant savings allocation shares.

As modeling results show, coal production subsidies elimination has no severe impact on macroeconomic variables, including households' income. Depending on the investigated scenario, GDP either is not influences, or insignificantly growth by 0,4%. The latter option is observed for the cases of endogenous labor supply (*Table 2*).

Table 2. Coal production subsidies elimination: aggregate effects

Scenarios description	***S1***	***S2***	***S3***	***S4***	***S5***	***S6***	***S7***
Production tax rate, %	-3,1	0,0	3,4	3,4	3,4	3,4	3,4
Standard closure	+	+	+	-	-	-	-
Endogenous tax rate on private commodity consumption, fixed ratio of indirect tax revenue to national income	-	-	-	+	+	+	+
Fixed trade balance, endogenous savings allocation shares	-	-	-	-	+	-	+
Fixed real labor price, endogenous labor supply	-	-	-	-	-	+	+
Indicators, % change	***S1***	***S2***	***S3***	***S4***	***S5***	***S6***	***S7***
GDP	0,0	-0,0	-0,0	0,0	0,0	0,4	0,4
Regional household's income	-0,1	-0,1	-0,2	-0,7	-0,8	-0,4	-0,5
GDP price index	-0,0	-0,1	-0,1	-0,7	-0,7	-0,8	-0,8
Aggregate output	-0,0	-0,0	-0,0	-0,0	-0,0	0,4	0,4
Domestic sales	-0,0	-0,1	-0,1	-0,1	-0,1	0,3	0,3
Aggregate import	-0,0	-0,1	-0,1	-0,1	-0,1	0,2	0,2
Aggregate export	0,0	0,1	0,1	0,1	0,2	0,5	0,6

All scenarios lead to the moderate positive trade balance results, when export growth relatively faster than import. Trade balance deficit decrease is between 0,1%-0,4%. In addition, subsidies elimination lead to some general deflationary effects: GDP price index reduces by 0,1%-0,8%, although this reduction should be interpreted relative to the numeraire.

As long as studied policy option lead to the coal production decrease and corresponding sectoral employment reduction, real household's income falls. And although in aggregate this reduction does not exceed 0,8%, for some groups of households it may be much higher as long as severe subsidies elimination effects would be mainly faced by coal employees' families. In this context it would be beneficial to implement some type of direct compensatory cash payments to the appropriate households. Among studied options, the most preferential scenarios for households included government tax income increase, which sequentially led to some social transfers' growth.

On the sectoral level, coal production subsidies elimination leads to the relative prices increase for the corresponding products (*Table A.2*). As a result, domestic producers decrease their output level (*Table A.3*). Partially this fall is compensated by import volumes rise, but in general domestic sales volumes of "Other extraction" products decrease as well as aggregate sales (*Table A.4*).

Most of the substituted domestic coal is imported from Russia, which accounts for over 50% of total coal import increase in every scenario (*Table A.5*). Significant coal import increase also accounts for the rest of the world, while EU-27 and China face no trade gains. In the context of trade effects, coal subsidies elimination has no significant impact on other sectors import flows (*Table A.6*). The only exception is "Petroleum, coal products" sector, which faces moderate import volumes increase due to the deficit of domestic intermediate input.

At the same time, export side of Ukrainian economy, is more effected by investigated policy options. In this context few issues should be mentioned. *Firstly*, a straightforward decrease of "Other extraction" and linked industries export volumes may not have place in real world due to the products disaggregation issue.

As long as applied GTAP model represents aggregated coal industry it assumes the same technological, financial, trade, etc. issue for all types of coal. But in reality, coal that Ukraine imports from Russia and exports to EU substantially differs. So there is no straight link (substitution) between national production and trade flows for different coal ranks. In addition, most of the exported coal is produced on the private coal mines, while investigated policy options concern only state producers.

Secondly, under all studied scenarios there is a positive export volumes change. The magnitude of this shift highly depends on the closure options. The highest increase is observed for the fixed real wage options (*Table A.7*).

Finally, the highest export volumes growths are observed for the "Processed food", "Services" and "Other manufacturing" sectors. The latter includes metals, metal products, motor vehicles and parts, transport and electronic equipment, machinery and manufactures. In aggregate these industries account for almost 50% of total export increase.

While in aggregate considered policy options lead to positive welfare effects, for national economy results heavily depend on the closure assumptions. For all options except fixed real wage, Ukraine undergoes moderate welfare decrease (*Table A.8*). As decomposition analysis shows, within all scenarios national economy losses from the international capital flows and traded commodities relative prices shift (*Table A.9 – Table A.13*). At the same time, key positive effects arise due to the allocative efficiency and endowment commodities. This is especially representative for the fixed real wage closures, when aggregate welfare for Ukraine by over 400 mn USD (*Table A.12 – Table A.13*).

Summary and conclusions

Despite intensive development and implementation of government programs and sector-specific energy policies together with consideration of subsidies elimination as a strategic coal industry priority, governmental grants volumes for this economic activity are growing from year to year. As a result, in 2013 Ukrainian Government transferred over 13,3 bn UAH to State coal mines, which is a crippling burden for National Budget.

On the other hand, coal subsidies elimination process is highly complicated and painful, due to resulting unemployment issues, trade balance deficit growth and energy security level shift. In this context development of the appropriate policy options should take into consideration wide variety of feasible social and economic consequences. This paper estimates the effects of coal production subsidies elimination in Ukraine under different compensatory measures and economic conditions.

As results show, coal production subsidies elimination has no severe impact on key macroeconomic variables, except households' income. And although in aggregate its reduction does not exceed 0,8%, for some groups of households it may be much higher as long as severe subsidies elimination effects would be mainly faced by coal employees' families. In this context it would be beneficial to implement some type of direct compensatory cash payments to the appropriate households. Among studied options, the most preferential scenarios for households included government tax income increase, which sequentially led to some social transfers' growth.

On the sectoral level, coal production subsidies elimination leads to the relative prices increase for the corresponding products. As a result, domestic producers decrease their output level. Partially this fall is compensated by import volumes rise, but in general domestic sales volumes of "Other extraction" products decrease as well as aggregate sales.

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Finally, it is worth of note that obtained results should be treated with some awareness due to the distinctive features of underlying data and GTAP framework. In particular, for the case of full subsidies cut (production tax changes from -6,1% (subsidization) to 3,4% (taxation)) "Other extraction" sectoral output declines by only 3,2%. Conducted sensitivity analysis (versus substitution and transformation elasticities' values) did not significantly change the results: output decrease did not exceed 4%. At the same time, according to the calculations based on Ukrainian single-country CGE model, coal subsidies elimination could lead to much more severe output decline – up to 20% in the benchmark scenario. Such results go in line with opinions of some Ukrainian experts. Government coal mines produced 29% of Ukrainian coal in 2013. Almost all of them were lossmaking and difference between cost of production and real market price was more than 170%. So it is highly probable that in case of subsidies elimination most of the government mines would be closed down and production could decline significantly (by more than 15%). In this context, obtained results should be treated in a more qualitative than quantitative manner, in a way that they show the nature and directions of policy induced changes.

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Appendix

Table A.1. Scenarios description

Features \ Scenarios	*S1*	*S2*	*S3*	*S4*	*S5*	*S6*	*S7*
Production tax rate, %	-3,1	0,0	3,4	3,4	3,4	3,4	3,4
Standard closure	+	+	+	-	-	-	-
Endogenous tax rate on private commodity consumption, fixed ratio of indirect tax revenue to national income	-	-	-	+	+	+	+
Fixed trade balance, endogenous savings allocation shares	-	-	-	-	+	-	+
Fixed real labor price, endogenous labor supply	-	-	-	-	-	+	+

Table A.2. Domestic market price change, %

Sectors \ Scenarios	*S1*	*S2*	*S3*	*S4*	*S5*	*S6*	*S7*
Land	0,1	0,2	0,4	0,6	0,6	1,5	1,5
Unskilled labor	-0,1	-0,3	-0,5	-0,5	-0,5	-0,9	-1,0
Skilled labor	-0,1	-0,2	-0,3	-0,4	-0,5	-0,9	-1,0
Capital	-0,1	-0,2	-0,4	-0,4	-0,4	-0,2	-0,3
Natural resources	-5,4	-10,5	-15,9	-15,7	-15,7	-14,7	-14,6
Farming	0,0	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1
Oil	-0,1	-0,2	-0,3	-0,3	-0,3	-0,2	-0,2
Gas	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Other minerals	0,0	0,0	-0,1	-0,1	-0,1	-0,1	-0,1
Other extraction	1,3	2,7	4,5	4,5	4,5	4,7	4,6
Processed food	0,0	-0,1	-0,2	-0,2	-0,2	-0,3	-0,3
Petroleum, coal products	0,2	0,5	0,8	0,8	0,8	0,8	0,8
Chemical, rubber, plastic products	0,0	0,0	0,0	0,0	0,0	-0,1	-0,1
Mineral products	0,0	0,0	0,0	0,0	-0,1	-0,2	-0,2
Ferrous metals	0,0	0,0	0,1	0,1	0,1	0,0	0,0
Other manufacturing	0,0	-0,1	-0,1	-0,1	-0,2	-0,2	-0,2
Electricity, gas, water, construction	0,0	-0,1	-0,1	-0,1	-0,2	-0,3	-0,3
Trade	-0,1	-0,2	-0,3	-0,3	-0,4	-0,4	-0,4
Transport	0,0	0,0	0,0	0,0	0,0	-0,1	-0,1
Services	-0,1	-0,2	-0,3	-0,3	-0,4	-0,5	-0,5
Dwellings	-0,1	-0,2	-0,4	-0,4	-0,4	-0,3	-0,3
Capital goods	0,0	0,0	-0,1	-0,1	-0,1	-0,2	-0,2

Table A.3. Output effects, % change

Sectors \ Scenarios	*S1*	*S2*	*S3*	*S4*	*S5*	*S6*	*S7*
Land	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Unskilled labor	0,0	0,0	0,0	0,0	0,0	0,7	0,7
Skilled labor	0,0	0,0	0,0	0,0	0,0	0,8	0,8
Capital	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Natural resources	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Farming	0,0	0,1	0,2	0,2	0,2	0,4	0,4
Oil	0,0	0,0	0,0	0,1	0,1	0,1	0,1
Gas	0,0	0,1	0,2	0,2	0,2	0,2	0,3
Other minerals	0,0	0,0	0,0	0,0	0,1	0,2	0,3
Other extraction	-1,0	-2,0	-3,2	-3,2	-3,2	-3,0	-3,0
Processed food	0,1	0,2	0,3	0,4	0,4	0,7	0,7
Petroleum, coal products	-0,3	-0,6	-1,0	-1,0	-1,0	-0,7	-0,7
Chemical, rubber, plastic products	0,0	0,0	0,0	0,1	0,2	0,6	0,7
Mineral products	0,0	0,0	0,0	0,1	0,1	0,6	0,6
Ferrous metals	-0,1	-0,2	-0,3	-0,3	-0,2	0,1	0,2
Other manufacturing	0,1	0,3	0,5	0,6	0,6	1,1	1,2
Electricity, gas, water, construction	0,0	-0,1	-0,1	-0,1	-0,1	0,3	0,3
Trade	0,0	0,0	0,0	0,2	0,2	0,6	0,6
Transport	0,0	0,0	-0,1	0,0	0,0	0,3	0,3
Services	0,0	0,1	0,2	0,0	0,0	0,5	0,5
Dwellings	0,0	0,0	0,0	0,2	0,1	0,5	0,4
Capital goods	-0,1	-0,2	-0,3	-0,4	-0,4	-0,1	-0,1

Table A.4. Domestic sales change, %

Sectors \ Scenarios	*S1*	*S2*	*S3*	*S4*	*S5*	*S6*	*S7*
Farming	0,0	0,1	0,1	0,2	0,2	0,4	0,4
Oil	0,0	0,0	0,0	0,0	0,1	0,1	0,1
Gas	0,0	0,1	0,2	0,2	0,2	0,2	0,3
Other minerals	0,0	-0,1	-0,1	0,0	0,0	0,4	0,4
Other extraction	-0,6	-1,3	-2,2	-2,1	-2,1	-1,9	-1,9
Processed food	0,0	0,1	0,1	0,2	0,2	0,6	0,6
Petroleum, coal products	-0,2	-0,5	-0,8	-0,7	-0,7	-0,4	-0,4
Chemical, rubber, plastic products	0,0	0,0	-0,1	0,1	0,1	0,7	0,7
Mineral products	0,0	0,0	0,0	0,0	0,1	0,5	0,5
Ferrous metals	0,0	-0,1	-0,1	-0,1	0,0	0,4	0,5
Other manufacturing	0,0	0,1	0,2	0,2	0,3	0,8	0,8
Electricity, gas, water, construction	0,0	-0,1	-0,2	-0,1	-0,1	0,3	0,3
Trade	0,0	0,0	0,0	0,2	0,1	0,6	0,5
Transport	0,0	-0,1	-0,2	-0,1	-0,1	0,3	0,3
Services	0,0	0,1	0,1	-0,1	-0,1	0,4	0,4
Dwellings	0,0	0,0	0,0	0,2	0,1	0,5	0,4

Table A.5. Change of "Other extraction" export to Ukraine, mn USD

Regions \ Scenarios	*S1*	*S2*	*S3*	*S4*	*S5*	*S6*	*S7*
USA	1,5	3,3	5,4	5,5	5,5	5,9	5,9
EU-27	0,2	0,4	0,7	0,7	0,7	0,7	0,7
Russia	11,2	23,6	39,0	39,8	39,8	42,7	42,5
China	0,0	0,1	0,1	0,1	0,1	0,2	0,2
Rest of the World	5,8	12,2	20,2	20,6	20,6	22,1	22,0
Total	**18,7**	**39,5**	**65,4**	**66,8**	**66,7**	**71,6**	**71,3**

Table A.6. Import volumes change for Ukraine, %

Sectors \ Scenarios	*S1*	*S2*	*S3*	*S4*	*S5*	*S6*	*S7*
Farming	0,0	0,0	-0,1	0,1	0,1	0,4	0,4
Oil	-0,4	-0,8	-1,3	-1,3	-1,3	-1,0	-0,9
Gas	0,0	-0,1	-0,1	-0,1	0,0	0,3	0,4
Other minerals	0,0	-0,1	-0,1	-0,1	0,0	0,3	0,4
Other extraction	2,2	4,7	7,8	8,0	8,0	8,6	8,5
Processed food	-0,1	-0,2	-0,3	-0,2	-0,3	-0,1	-0,2
Petroleum, coal products	0,2	0,5	0,8	0,9	0,9	1,2	1,2
Chemical, rubber, plastic products	0,0	0,0	0,0	0,1	0,1	0,4	0,4
Mineral products	-0,1	-0,1	-0,2	-0,1	-0,1	0,1	0,1
Ferrous metals	0,1	0,1	0,2	0,3	0,3	0,6	0,6
Other manufacturing	-0,1	-0,1	-0,2	-0,2	-0,2	0,1	0,1
Electricity, gas, water, construction	-0,1	-0,2	-0,4	-0,3	-0,4	-0,2	-0,3
Trade	-0,2	-0,3	-0,6	-0,5	-0,6	-0,2	-0,2
Transport	0,0	-0,1	-0,1	0,0	-0,1	0,3	0,2
Services	-0,1	-0,3	-0,5	-0,6	-0,7	-0,5	-0,5
Dwellings	0,0	0,0	0,0	0,1	0,1	0,4	0,4

Table A.7. Change of export volumes from Ukraine, mn USD

Regions \ Scenario	*S1*	*S2*	*S3*	*S4*	*S5*	*S6*	*S7*
Farming	3,7	7,8	12,7	8,8	10,7	9,4	11,2
Oil	0,0	0,1	0,1	0,1	0,1	0,1	0,1
Gas	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Other minerals	0,5	1,0	1,6	1,6	1,9	2,0	2,2
Other extraction	-19,9	-40,3	-63,5	-64,0	-63,9	-65,4	-65,3
Processed food	10,4	21,6	35,3	35,0	39,6	53,5	57,1
Petroleum, coal products	-19,2	-40,1	-65,6	-66,1	-65,7	-66,9	-66,5
Chemical, rubber, plastic products	1,1	2,1	3,2	5,6	10,1	28,0	31,3
Mineral products	0,3	0,6	0,9	1,1	1,5	3,6	3,9
Ferrous metals	-15,3	-32,4	-53,9	-49,9	-39,8	-1,1	6,5
Other manufacturing	36,0	75,0	122,0	132,0	149,0	216,0	229,0
Electricity, gas, water, construction	2,5	5,2	8,5	9,6	11,5	19,6	21,0
Trade	3,4	7,0	11,5	12,2	13,3	14,3	15,3
Transport	0,4	0,8	1,1	2,5	5,7	11,4	14,0
Services	14,9	31,2	51,1	56,3	61,6	85,5	89,3
Dwellings	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total	**18,7**	**39,4**	**65,2**	**84,8**	**135,0**	**310,0**	**349,0**

Table A.8. Aggregate welfare change by countries, mn USD

Regions \ Scenarios	*S1*	*S2*	*S3*	*S4*	*S5*	*S6*	*S7*
Ukraine	-12,4	-27,9	-49,3	-29,0	-47,3	475,0	442,0
USA	2,8	5,8	9,4	5,3	7,5	-7,5	-5,1
EU-27	-2,6	-5,1	-7,9	-11,9	-9,3	-15,7	-13,2
Russia	0,8	1,5	2,3	9,0	11,6	43,5	44,8
China	0,0	0,1	0,1	-0,5	0,3	-0,1	0,7
Rest of the World	7,2	14,8	24,1	32,4	40,4	85,5	91,1
Total	**-4,2**	**-10,8**	**-21,4**	**5,2**	**3,2**	**580,0**	**560,0**

Table A.9. Welfare decomposition (Scenario 3), mn USD

Regions \ Welfare effects	*Allocative efficiency*	*Endowment commodities*	*Terms of trade*	*Price of capital goods*	*Changes in preferences*	*Total*
Ukraine	-24,8	0,0	-7,2	-17,3	0,0	**-49,3**
USA	1,7	0,0	4,1	3,6	0,0	**9,4**
EU-27	4,0	0,0	-15,1	3,1	0,0	**-7,9**
Russia	-11,2	0,0	11,6	1,8	0,0	**2,3**
China	0,8	0,0	-3,5	2,8	0,0	**0,1**
Rest of the World	8,1	0,0	10,1	5,9	0,0	**24,1**
Total	**-21,4**	**0,0**	**0,0**	**0,0**	**0,0**	**-21,4**

Table A.10. Welfare decomposition (Scenario 4), mn USD

Regions \ Welfare effects	*Allocative efficiency*	*Endowment commodities*	*Terms of trade*	*Price of capital goods*	*Changes in preferences*	*Total*
Ukraine	2,0	0,0	-11,7	-19,3	0,0	**-29,0**
USA	1,2	0,0	1,7	2,5	0,0	**5,3**
EU-27	3,1	0,0	-18,7	3,7	0,0	**-11,9**
Russia	-8,7	0,0	16,2	1,6	0,0	**9,0**
China	0,4	0,0	-4,7	3,8	0,0	**-0,5**
Rest of the World	7,5	0,0	17,2	7,7	0,0	**32,4**
Total	**5,3**	**0,0**	**0,0**	**-0,1**	**0,0**	**5,2**

Table A.11. Welfare decomposition (Scenario 5), mn USD

Regions \ Welfare effects	*Allocative efficiency*	*Endowment commodities*	*Terms of trade*	*Price of capital goods*	*Changes in preferences*	*Total*
Ukraine	-2,1	0,0	-22,7	-22,4	-0,1	**-47,3**
USA	1,4	0,0	2,4	3,7	0,0	**7,5**
EU-27	3,1	0,0	-16,7	4,3	0,0	**-9,3**
Russia	-8,6	0,0	18,3	1,9	0,0	**11,6**
China	0,6	0,0	-4,4	4,1	0,0	**0,3**
Rest of the World	9,0	0,0	23,1	8,3	0,0	**40,4**
Total	**3,5**	**0,0**	**-0,1**	**-0,1**	**-0,1**	**3,2**

Table A.12. Welfare decomposition (Scenario 6), mn USD

Regions \ Welfare effects	*Allocative efficiency*	*Endowment commodities*	*Terms of trade*	*Price of capital goods*	*Changes in preferences*	*Total*
Ukraine	215,0	354,0	-59,0	-35,6	0,0	**475,0**
USA	-0,4	0,0	-7,8	0,8	0,0	**-7,5**
EU-27	1,1	0,0	-25,0	8,2	0,0	**-15,7**
Russia	1,9	0,0	40,5	1,1	0,0	**43,5**
China	-0,3	0,0	-8,3	8,5	0,0	**-0,1**
Rest of the World	9,1	0,0	59,4	17,0	0,0	**85,5**
Total	**227,0**	**354,0**	**-0,2**	**-0,1**	**0,0**	**580,0**

Table A.13. Welfare decomposition (Scenario 7), mn USD

Regions \ Welfare effects	*Allocative efficiency*	*Endowment commodities*	*Terms of trade*	*Price of capital goods*	*Changes in preferences*	*Total*
Ukraine	205,0	343,0	-67,5	-37,9	-0,1	**442,0**
USA	-0,1	0,0	-6,9	2,0	0,0	**-5,1**
EU-27	1,2	0,0	-22,9	8,6	0,0	**-13,2**
Russia	1,8	0,0	41,7	1,4	0,0	**44,8**
China	-0,1	0,0	-7,9	8,7	0,0	**0,7**
Rest of the World	10,5	0,0	63,4	17,2	0,0	**91,1**
Total	**218,0**	**343,0**	**-0,3**	**-0,2**	**-0,1**	**560,0**