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Toni Riipinen

Energy market liberalisation in the FSU – simulations with the GTAP model

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Russian economy and economic policy
Russia's international economic relations
Baltic economies
Pekka.Sutela@bof.fi

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Baltic economies
Tuuli.Koivu@bof.fi

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Russian financial system
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Tuomas.Komulainen@bof.fi

Mr Iikka Korhonen, economist
Baltic economies
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Iikka.Korhonen@bof.fi

Mr Vesa Korhonen, economist
Russia's international economic relations
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Issues related to the EU enlargement
Vesa.Korhonen@bof.fi

Ms Seija Lainela, economist
Russian economy and economic policy
Seija.Lainela@bof.fi

Mr Jukka Pirttilä, research supervisor
Public economics
Transition economics
Jukka.Pirttila@bof.fi

Mr Jouko Rautava, economist
Russian economy and economic policy
Jouko.Rautava@bof.fi

Mr Jian-Guang Shen, economist
Chinese economy and economic policy
Financial crises
Jian-Guang.Shen@bof.fi

Ms Laura Solanko, economist
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Public economics
Laura.Solanko@bof.fi

Ms Merja Tekoniemi, economist
Russian economy and economic policy
Merja.Tekoniemi@bof.fi

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Contact us

Bank of Finland
Institute for Economies inTransition, BOFIT
PO Box 160
FIN-00101 Helsinki

Phone: +358 9 183 2268
Fax: +358 9 183 2294

E-mail: bofit@bof.fi
Internet: www.bof.fi/bofit

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Toni Riipinen *

Energy market liberalisation in the FSU – simulations with the GTAP model

Abstract

This work considers effects of energy market liberalisation in the countries of the former Soviet Union (FSU). Our analysis is based on a computable general equilibrium (CGE) model called the Global Trade Analysis Project (GTAP). This specialised model makes it possible to evaluate effects in a general equilibrium set-up. Energy market reforms are widely discussed in the literature, but the use of CGE models has been limited. In the main part of the paper, we perform two experiments. The first is a benchmark liberalisation experiment in which all government taxes and subsidies are removed. The second is an attempt to simulate an increase in the export capacity of energy commodities into the European markets. In general, we find that liberalisation of FSU energy markets would increase welfare in the EU countries, while in the FSU welfare would decrease. This result is mainly due to the terms of trade effect, as export prices of FSU countries decrease.

Keywords: energy, computable general equilibrium models, former Soviet Union, welfare analysis

* LTT-TUTKIMUS OY • LTT RESEARCH LTD Pohjoinen Rautatiekatu 21 B • FIN-00100 HELSINKI, Finland • tel: +358-9-431 38570 • fax: +358-9-408 417 • www.ltt-tutkimus.fi

Toni Riipinen

Energy market liberalisation in the FSU – simulations with the GTAP model

Tiivistelmä

Tutkimuksessa käsitellään entisen Neuvostoliiton maiden energiamarkkinoiden vapauttamista. Analyysi perustuu Global Trade Analysis Project (GTAP) -malliin, joka on yleisen tasapainon malli. Energiamarkkinoiden vapauttamista on käsitelty kirjallisuudessa varsin paljon, mutta yleisen tasapainon malleja ei juuri ole käytetty tähän tarkoitukseen. Tutkimuksen pääosassa suoritetaan kaksi hypoteettista uudistusta. Ensimmäisessä kaikki energiasektorin verot ja tuet poistetaan. Toisessa simuloidaan Euroopan markkinoille suuntautuvan energianviennin kapasiteetin kasvua. Tuloksien mukaan energia-markkinoiden vapauttaminen kohentaa hyvinvointia EU-maissa, mutta heikentää sitä entisen Neuvostoliiton maissa. Tämä johtuu lähinnä vaihtosuhteen muutoksista, koska entisen Neuvostoliiton maiden vientihinnat laskevat.

Asiasanat: energia, yleisen tasapainon malli, entisen Neuvostoliiton maat, hyvinvointianalyysi

1 Introduction

Energy commodities, particularly natural gas and electricity, are central to the Russian economy. Russia's natural gas reserves constitute roughly a third of world's natural gas reserves (OECD, 2002) and Russia produces a quarter of all gas sold on the world market. It is estimated that oil, gas and oil products amounted to approximately 50% of Russia's total exports in 2000–2001 (Tabata, 2002).

The energy sector is vital not only to Russia's economic development, but other countries as well. For example, a large share of Finland's demand for energy commodities is satisfied with Russian imports.

The share of Russian energy in European markets could increase, but the EU is reluctant to become overly dependent on Russian energy and considers Russian energy markets problematic. The natural gas industry, for example, is dominated by RAO Gazprom, which accounts for nearly 90% of the gas produced and supplied to Europe from Russia. Moreover, the government and public sector maintain a strong presence in Russia's energy industries, making the economic environment far from competitive or efficient. EU decision-makers and many others see liberalisation of Russia's energy markets as a prerequisite to development of these industries.

This work considers effects of market liberalisation in the countries of the former Soviet Union (FSU). Our analysis is based on a computable general equilibrium (CGE) model modified for use by the Global Trade Analysis Project (GTAP). This specialised model makes it possible to evaluate effects in a general equilibrium set-up. Energy market reforms are widely discussed in the literature, but the use of CGE models has been limited. In the case of the FSU, a major drawback has been the lack of distinction in the current database of regions and countries of the FSU.

We perform two experiments. The first is a benchmark liberalisation experiment in which all government taxes and subsidies are removed. The second is an attempt to simulate an increase in the export capacity of energy commodities into the European markets. A simulation of an increase in the market price of gas in the FSU is also provided. While this third exercise is not directly linked to the liberalisation experiments, it provides some interesting results. The gas price simulation is presented in Appendix 1.

The work is organised as follows: The second section introduces the CGE model and assumptions used in the simulations. The third section concentrates on the energy market liberalisation experiment, while the fourth discusses simulations of increased export capacity. The final section concludes.

2 The GTAP model, database and reference case

The Global Trade Analysis Project (GTAP) model and database are commonly used for analysing multilateral trade agreements.[1] GTAP offers a variety of products, including data, models and software for multi-region general equilibrium analysis. Several international organisations, as well as individual governments, use the model and database extensively in assessing the economic implications of such things as trade policy changes and market reforms. The standard GTAP model is documented in Hertel (1997).

[1] The project web page is http://www.agecon.purdue.edu/gtap

The current GTAP database (version 5) is publicly available and contains information on 66 regions and 57 commodities, including (i) comprehensive input-output data by region, (ii) bilateral trade and protection data, and (iii) energy price, quantity and tax data.[2]

The standard GTAP model has a competitive economic environment (zero-profits). On the demand side, a regional household consisting of private households and government maximizes utility. The production structure of the model is fairly complicated as it belongs to the category of top-down CGE models. At the top of the production structure, value-added factors of production are combined with intermediate goods. The bilateral trade flows between regions are handled with the Armington assumption, which is based on the idea that imported intermediates are separable from domestically produced intermediate inputs, i.e. firms first decide on the sourcing of their inputs, then, based on the resulting composite import price, they determine the optimal mix of imported and domestic goods.[3] A full description of the production structure appears in Hertel (1997).

Policy instruments enter the model in the form of taxes related to international trade (import duties and export subsidies), as well as direct output and consumption taxes. For our purpose, we aggregate countries and sectors into ten regions and ten industries (Table 1).

Table 1. Regional and commodity coverage

Identifier	Countries in Region	Sectors in region	Identifier
FIN	Finland	Coal	COL
EU 14	European Union	Oil	OIL
ACC	Accession Countries	Gas	GAS
FSU	Former Soviet Union	Distribution of gas	GDT
NAM	North America	Electricity	ELEC
JAP	Japan	Agricultural products and processed food	FOOD
ASI	Developing markets in Asia	Chemicals, rubber, plastic products, raw materials	CHEM
LAM	Developing markets in Latin America	Manufactured products	MNFS
ENE	Oil Producing Countries	Trade, transport	TRANS
ROW	Rest of the World	Composite of other sectors	COMP

On the input side the model is aggregated into four inputs: labour (aggregate of skilled and semi-skilled labour), capital, natural resources and land.

All reforms simulated in this work are assumed to take place in 2005. The GTAP database corresponds to the global economy in 1997, so we first need to create a reference scenario that corresponds to the global economy in 2005.

In projections the growth of GDP, labour force and the total factor productivity in different industries are exogenously imposed. Productivity growth is assumed to vary between sectors (industry, services and resources and agriculture). The growth estimates for GDP, labour force and the levels of productivity by sector are presented in Table 2.[4] The figures are based on Frandsen, Soren and Jensen (2000).

[2] A complete description of the data can be found in http://www.agecon.purdue.edu/gtap/database

[3] Critics of the Armington assumption claim the functional form is too restrictive. Moreover, industrial organization literature on imperfect competition product differentiation is seen as endogenous rather than as exogenous as in the Armington approach. Despite this critique, however, the assumption permits the tracking of bilateral trade flows and explanation of cross-hauling of similar products, which is why it is included in almost any CGE trade model.

[4] It is assumed that the figures in Table 2 represent the annual average change in 1997-2005. The results in later sections are not sensitive to the figures used to construct this reference case.

Table 2. Annual GDP, labour force and productivity growth

Region	Annual increase (%)		Productivity increase (%)		
	GDP	Labour	Industrial sector	Service sector	Agricultural Sector
Rest of EU	2.4	0.1	1.0	0.5	1.4
Finland	3.0	0.1	1.0	0.5	1.4
Accession countries	4.0	0.1	1.3	0.1	0.4
North America	2.6	0.9	1.0	0.5	1.4
Japan	1.9	0.0	0.5	0.3	0.7
Developing markets in Asia	6.3	1.5	1.4	0.7	1.9
Oil producers	4.0	3.1	0.5	0.3	0.7
Rest of the World	2.9	2.3	0.5	0.3	0.7
Latin America	4.2	2.1	1.0	0.5	1.4
Former Soviet Union	0.9	0.5	0.3	0.1	0.4

To conclude this short introduction to the GTAP model and database, the share of different sectors from the total production of the FSU according to the GTAP database are presented in Table 3.

Table 3. Shares of FSU total production by sector

Sectors in region	Identifier	Share of total FSU production
Coal	COL	1 %
Oil	OIL	4 %
Gas	GAS	4 %
Distribution of gas	GDT	1 %
Electricity	ELEC	4 %
Agricultural products and processed food	FOOD	8 %
Chemicals, rubber, plastic products, raw materials	CHEM	12 %
Manufactured products	MNFS	14 %
Trade, transport	TRANS	7 %
Composite of other sectors	COMP	44 %

3 Liberalisation of energy markets in the former Soviet Union

We now focus on the possible effects of a liberalisation of energy markets in the FSU. Despite a substantial body of literature on the subject, CGE models have rarely been applied due to the above-mentioned drawbacks. Nevertheless, significant policy changes such as reforms in energy markets necessarily result in economy-wide general equilibrium effects. Hence, CGE models can be quite useful in analysis of such policy changes.

While it is unlikely the reform of energy markets implies the total abolition of taxes and subsidies, such a scenario provides a natural benchmark. Thus, in our first experiment we consider the total abolition of taxes and subsidies for domestic production, as well as the complete elimination of import and export tariffs on energy commodities. Our second experiment considers an internal liberalisation that leaves restrictions on international trade intact. No further policy changes in the other sectors of the economy are assumed.

3.1 FSU energy markets according to the GTAP database

What government interventions does the GTAP database imply for energy commodities? The level of government interventions determines the shocks needed to simulate liberalisation experiments. Five of GTAP sectors are classified as energy commodities (coal, oil, gas, distribution of gas and electricity).

Table 4 lists ad valorem rates of three types of taxes for these five sectors obtained from the GTAP database.[5]

Table 4. Ad valorem tax rates on FSU energy commodities in the GTAP database

	Output tax (%)	Import duty (%)	Export tax (%)
Coal	-0.5	20.5	10.3
Oil	5.2	15.2	22.2
Gas	12.1	13.7	18.1
Distribution of gas	12.1	19.0	2.0
Electricity	-25.3	23.6	2.0

Table 4 highlights two policy approaches in Russia. Production of coal and electricity is subsidised through a direct output subsidy. Production of oil and gas is subject to a direct output tax. Domestic production of all of the energy commodities is protected from international competition with a tariff barrier. Import duties are highest for coal and electricity, and duties are clearly positive for all energy commodities. Tariffs are imposed on all exported energy commodities.[6]

For purposes of comparison, Table 5 lists the same tax rates for the region consisting of oil producing countries (ENE). In particular, subsidies for production of electricity are lower in ENE than in the FSU. On the other hand, the ENE region protects domestic

[5] The GTAP model incorporates tools for imposing exogenous tax rates obtained from outside sources and suggests a possible area for future work.
[6] Gas exports to the EU are believed to be one of the most important sources of tax revenues for the Russian government (see the OECD's latest economic survey of the Russian Federation).

production of coal and oil with a higher import tariff barrier than the FSU. The opposite is true for imports of gas and electricity. Export tariffs on ENE energy commodities are a much lower than in the FSU.

Table 5. Ad valorem tax rates on energy commodities in ENE (Oil producing countries) according to the GTAP database

	Output tax (%)	Import duty (%)	Export tax (%)
Coal	1.3	25.8	0.1
Oil	1.5	60.3	7.9
Gas	6.3	1.4	8.1
Electricity	-1.9	1.7	0.6

The shares of energy commodities in the total of FSU exports (not counting exports within FSU regions) are as follows: coal 2%, oil 17%, gas 12% and electricity 1%. The importance of oil and gas is clearly largest when measured by export shares. Measured as the share of total production, oil, gas and electricity are the most important FSU energy commodities in the GTAP database. The share of production of coal is about 1%. Oil, gas and electricity each represent about 4% of total production.

3.2 Economy-wide effects of liberalisation of FSU energy markets

3.2.1 Economy-wide effects of total liberalisation

The GTAP model in its standard form is a static CGE model with a perfectly competitive economic environment. Obviously, this is somewhat restrictive with respect to policy change simulations.[7] Nevertheless, the structure of the standard model incorporates features useful in a benchmark experiment of a total liberalisation of energy markets.

The GTAP model considers three price levels. Thus, the price of a commodity can be evaluated at the level of individual agents, regional market prices or the world price. The difference between price levels for a particular commodity gives us the taxes related to the production and trade of commodities.

What does the liberalisation experiment imply from the GTAP-model point of view? When government interventions are abolished the various price levels converge. Thus, as import and export duties are removed, regional market price levels approach the world price level.

Consider now what a competitive economic environment free of government interventions might mean in the real world with several price levels (although the world price level is hypothetical in most cases). Even for tradable commodities, national market prices typically differ from world prices due to market imperfections, impediments to trade and other issues. Moreover, market prices are hard to identify in most cases. Even standardised commodities (e.g. food products) rarely have a uniform market price. The more an enterprise has market power, the more it is able to differentiate prices among groups of customers to extract the surplus available. Thus, the concept of prices at the level of agents is relevant in most cases.

[7] See section 3.5 for a discussion of the model structure and caveats in interpreting the results.

Price convergence is the obvious real-world motivation for introducing market reforms to reduce the level of government intervention and make markets more competitive. As firms lose pricing power, a uniform market price for a single commodity emerges. When governments adopt the policy of free trade with the rest of the world, regional market prices converge towards the world price level.[8] Similarly, market reform of prices formerly set by administrative procedures leads to price convergence with world prices, regional market prices and prices for individual agents.

Thus, while the structure of the standard GTAP model initially appears overly restrictive to capture the effects of real world market reforms, this is not actually the case. The model and the simulations in this work do not explicitly incorporate issues such as market power of firms or government price-setting, but are implicitly taken into account because of how the taxes are incorporated into the model and because the model is based on different levels of prices.

The standard model is particularly well suited to a benchmark experiments such as total liberalisation of a market. One intuition about such results is that they represent the total market reform situation, i.e. government interventions are abolished and a competitive market has emerged in the energy sector.

The economy-wide effects from liberalisation are measured with three variables. The first variable is the change in the equivalent variation (EV). Equivalent variation is a well-known variable in microeconomic theory. It is typically used to evaluate the change in money-metric welfare, giving an estimate for the amount of money that would have to be given to consumers to keep them as well off in the new equilibrium after the shock (with new prices) as in the old one (old prices). The second variable is the change in aggregate production (GDP) and the third is the change in regional terms-of-trade. These three variables give a good estimate of the overall impact on economic activity and welfare.

Figure 1 illustrates the welfare effects of FSU energy market liberalisation on regions.[9]

Figure 1 shows that the region that benefits most in absolute terms from liberalisation is the EU. Liberalisation is most detrimental for FSU countries. As might be expected, the net effect on world welfare is positive. Finland, like the rest of the EU, benefits with the accession countries of Central and Eastern Europe and North America. Oil-producing countries and the Rest of the World suffer a welfare loss. Note that the welfare changes are modest compared to the economic sizes of different regions. The change is largest for the EU (USD 3,300 million). The somewhat surprising result, however, is that the EU benefits and the FSU loses when FSU energy markets are liberalised.

[8] This obviously depends on the size of the markets. Policy changes in large countries affect world prices.
[9] The EV change relative to the GDP of a particular region is largest in the FSU (0.43% of GDP) and in ACC (0.36%). It is smallest in NAM, LAM and ASI (0.00%). The figure in EU14 is 0.04% and in Finland 0.06%.

Figure 1. Change in regional welfare

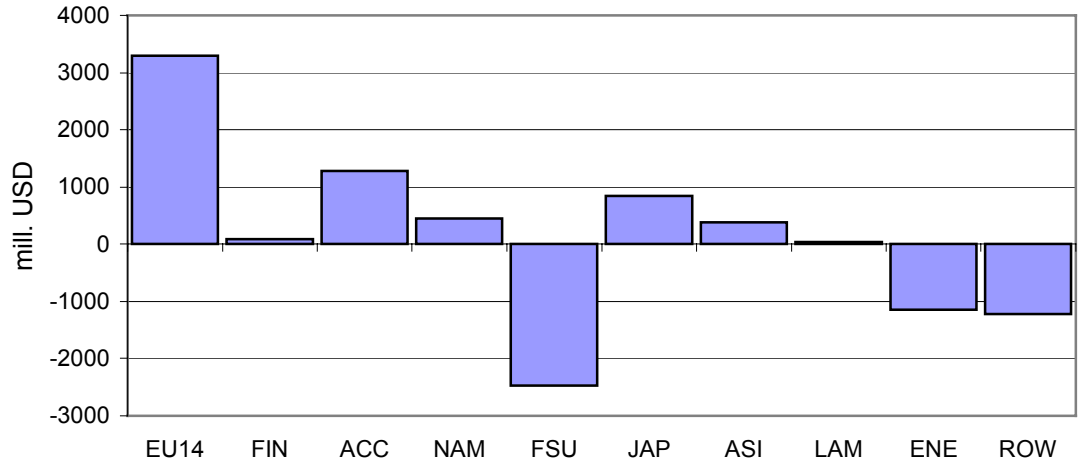
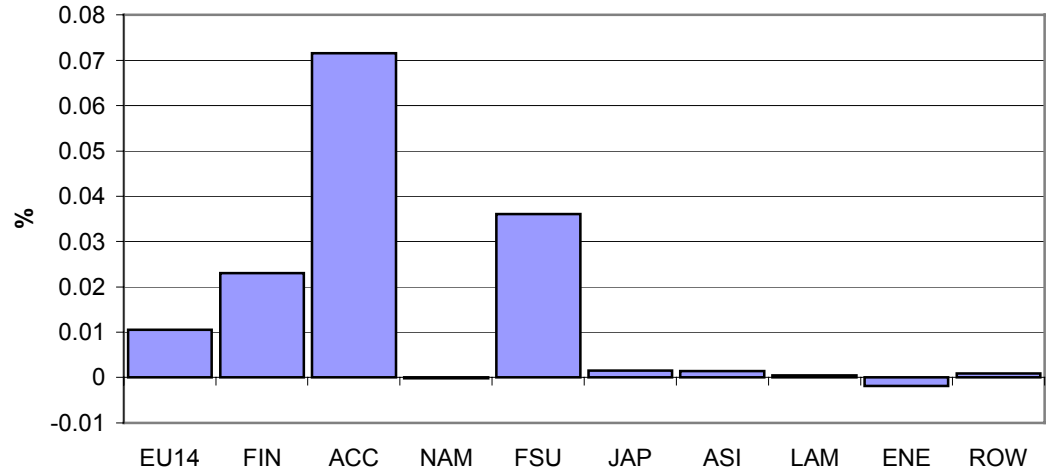


Figure 2 illustrates changes in the aggregate economic activity measured by regional GDP.

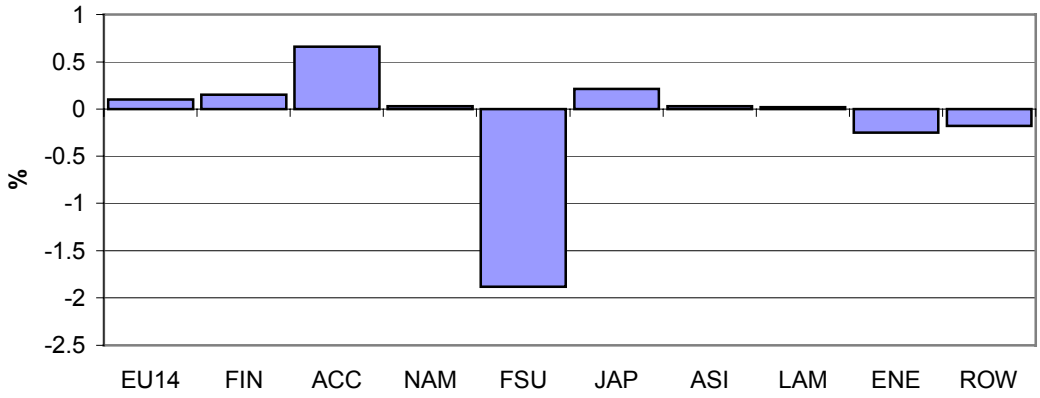
Figure 2. Change in regional GDP due to liberalisation



The effect of liberalisation on aggregate economic activity is negligible and largest for the accession countries (the change in GDP is still less than 0.1 %). The negative welfare effect on the FSU is not a result of a general decline in regional economic activity.

Figure 3 illustrates the changes in regional terms of trade.

Figure 3. Changes in regional terms of trade due to liberalisation

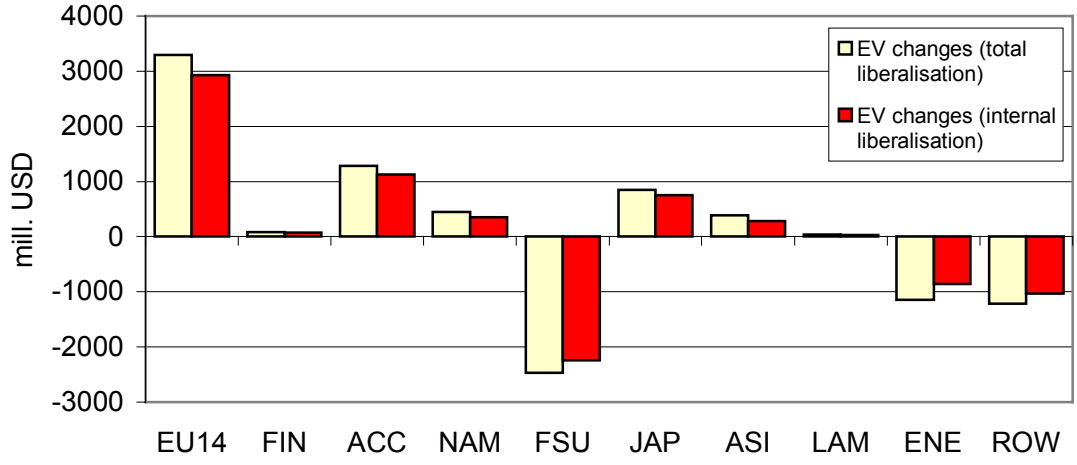


FSU terms of trade deteriorate severely. Indeed, all losing regions are those that face deteriorating terms of trade. The change in the gaining regions is positive. Finland and the rest of the EU and accession countries, as well as other welfare-enhancing regions, all experience positive terms-of-trade movements. This result suggests that the main source of welfare changes is the terms-of-trade effect.

3.2.2 Economy-wide effects of internal liberalisation

Figure 4 illustrates the welfare effects of energy market reforms in the FSU in the case where internal production taxes and subsidies are removed, while trade barriers (import tariffs and export subsidies) against the outside world are left untouched. We compare this experiment to the total liberalisation case.[10]

Figure 4. Changes in regional welfare under two liberalisation scenarios



[10] The GTAP model does not include other explicit trade barriers. Mechanisms such as quotas are not explicitly present in the database.

Figure 4 shows that the qualitative picture is similar in both liberalisation scenarios. The same regions lose or gain, with the EU again the biggest gainer.

When trade barriers remain in place, the welfare changes are unambiguously smaller. The benefiting regions gain less than under complete liberalisation. The losses for losing regions are also smaller.

The same pattern emerges from the relative changes in aggregate economic activity and regional terms of trade between the two liberalization scenarios. Figure 5 represents the changes in GDP in the two cases. Figure 6 illustrates terms-of-trade movements.

Figure 5. Changes in regional GDP

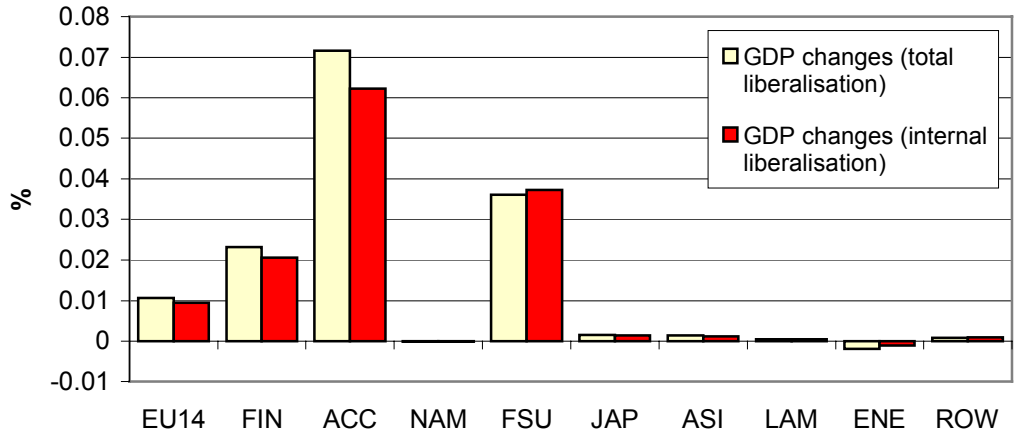
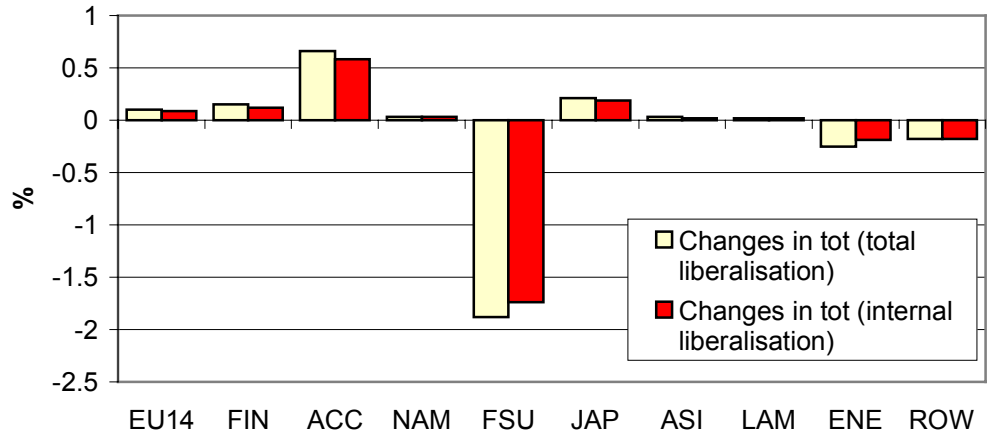


Figure 6. Changes in regional terms of trade



In summary, at the economy-wide level, the liberalisation of FSU energy markets results in relatively small effects on welfare or economic activity in both the total liberalisation experiment and internal liberalisation. The EU is the biggest gainer while the FSU appears to suffer most in welfare terms. The results are not sensitive to whether the liberalisation means abolishing domestic production taxes or subsidies, or whether barriers to international trade are lifted between the FSU and rest of the world. Domestic market interventions seem to play a larger role as far as the effects of market reforms are concerned.

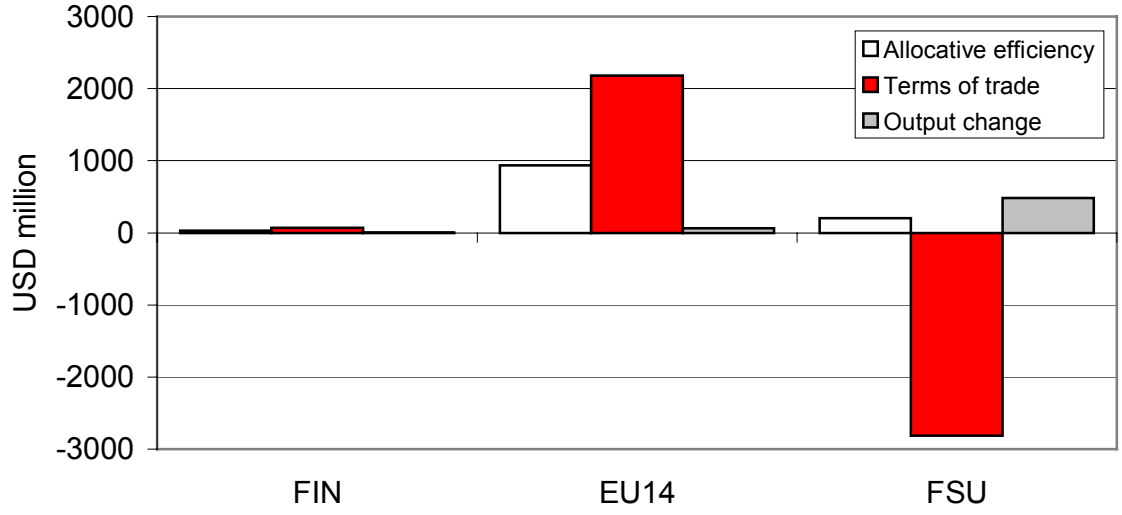
3.3 Sources of welfare changes

3.3.1 Decomposition of welfare change

Theory says that welfare changes may result from different sources. Terms-of-trade movements are one source; economic distortions are another. The GTAP model makes it possible to determine the relative role of these and other underlying reasons for the welfare changes.

Figure 7 illustrates the role of three largest components in the net welfare change. The decomposition is shown about the three regions of special interest (FSU, Finland and the rest of the EU) and the figures correspond to the total liberalisation experiment (the experiment concerning only internal liberalisation yields qualitatively similar results). The decomposition has three components: terms of trade, allocative efficiency (a measure of the increase or decrease of distortion in the economy) and aggregate output change.

Figure 7. Decomposition of welfare change



It is clear that the major contributor to the welfare change is the terms-of-trade effect. It is positive in the case of Finland and the EU, and negative for the FSU. This is as anticipated from Figures 3 and 6. It is also clear from Figure 7 that the liberalisation of FSU energy markets reduces economic distortions.

The latter finding is an intuitive one. Government interventions are present in the energy sectors of different regions. By definition, liberalisation of FSU markets reduces distortions. This, in turn, leads to gains in allocative efficiency. This argument does not apply to the EU, since no policy changes take place in that region. The gains from reduced distortions enter through an indirect channel. The FSU has arguably a comparative advantage in energy production and therefore in production of energy-intensive commodities. The liberalisation of the energy sectors increases the possibilities for the FSU to reap the benefits from this advantage. The liberalisation lowers the export prices (and subsequently import prices of the EU) of energy commodities leading to increased imports to the EU substituting domestic energy sources. This makes it possible for the EU-economy to allocate factors of production away from these sectors, which reduces distortions in the economy.

This same effect explains the negative effect from the terms-of-trade change in the FSU. Declining export prices for energy commodities contribute negatively to the FSU welfare. The flipside of the coin is that declining import prices of energy contribute positively to EU terms of trade.

To summarise, the decomposition of welfare changes illustrates the importance of international trade linkages in policy changes. Recall that the effects on the EU are transmitted solely through these linkages.

3.3.2 Sources of terms-of-trade movements

In the previous subsection, we argued that the effects of the liberalisation on the energy commodity prices are crucial for the terms-of-trade effects. It can be verified from the GTAP model. Terms of trade for a particular region may change because of changes in export prices, import prices or both. Terms of trade improve if the composite export price of exports increases relative to the composite price of imports. These movements can be traced back to individual commodities taking into account both the change in volumes and the change in prices of individual commodities.

Intuitively, we may view the terms-of-trade effect as giving an estimate of the change in terms under which a region engages in international trade. As shown in Figure 7, this change works in a positive direction for the EU and negatively for the welfare of the FSU.

Figures 8 and 9 illustrate the effect of the energy market reforms in Finland and the EU14 on export and import prices. The effects on Finland and the rest of the EU14 are similar. The price changes in the coal, oil and gas sectors contribute positively to the terms of trade in the region.

Figure 8. Export and import price changes by sector in Finland

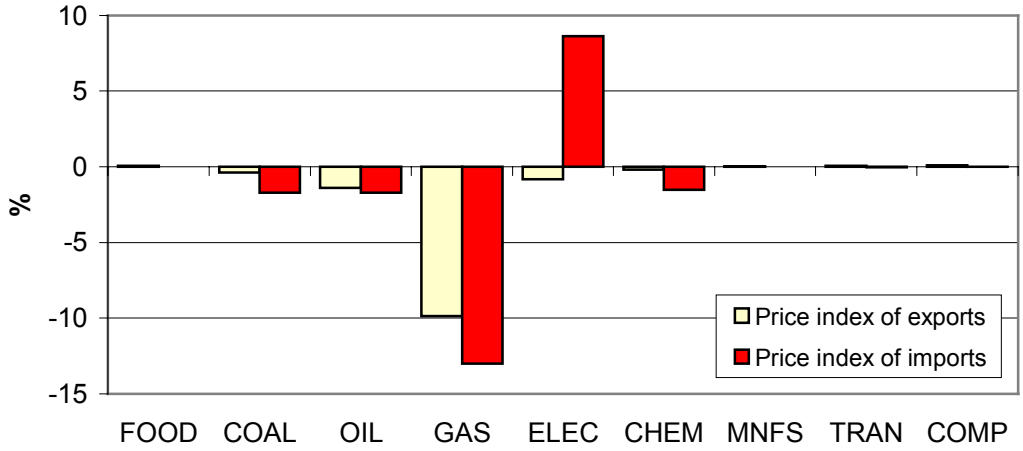
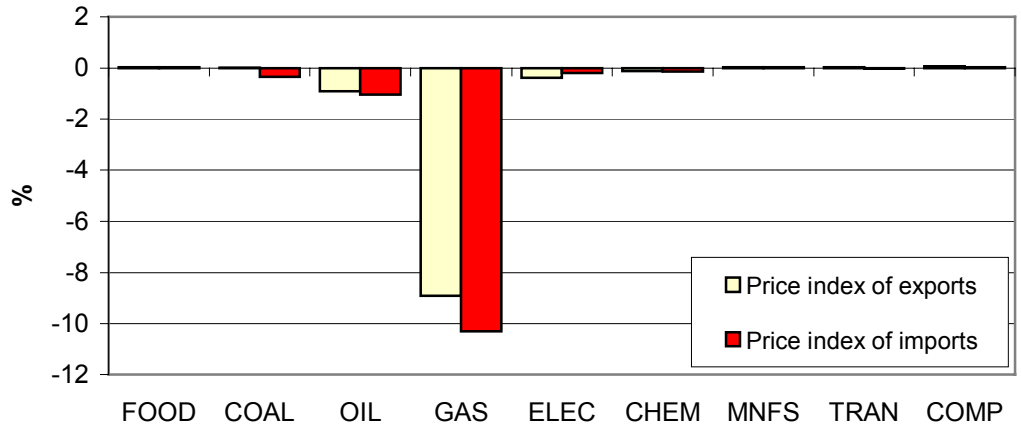


Figure 9. Export and import price changes by sector in the EU14



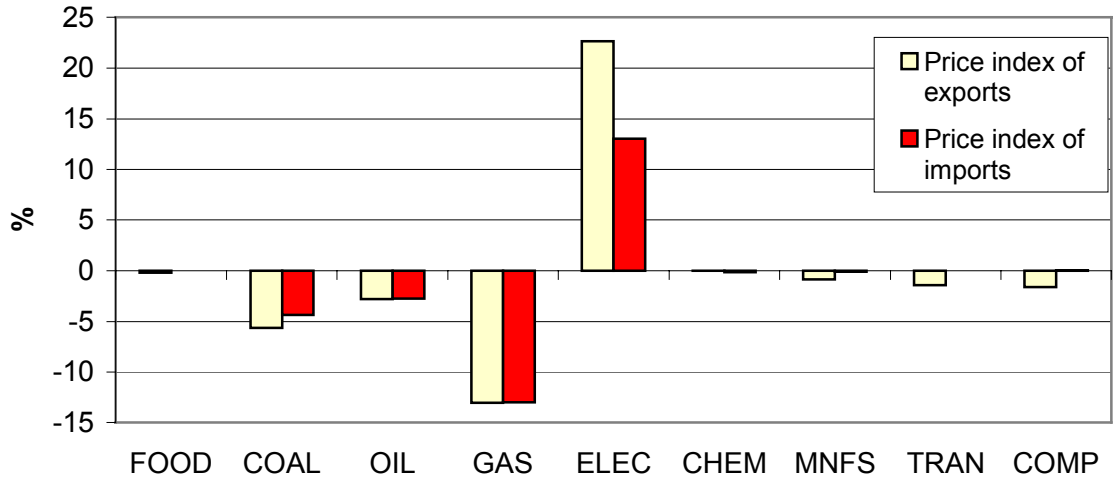
The difference is that the development of electricity prices is detrimental for Finland. The import price index of electricity jumps upwards as the removal of output subsidies from electricity production in the FSU results in a sharp increase in the market price of electricity in the FSU. Finland is a large importer of FSU electricity, so this effect is transmitted to the import price index of Finnish electricity. The change in the import price index of electricity in the EU14 is tiny compared to the Finnish case. This simply reflects the fact that FSU electricity accounts for a much larger proportion of electricity imports in Finland than in the EU14.

The other non-energy commodity sectors face limited price changes. The production of chemical products is the sector most affected in both Finland and the EU14.

In conclusion, Finland and the rest of the EU14 experience an improvement in their terms of trade, mainly due to falling import prices of energy commodities. The notable exception is the leap in the import price of electricity in Finland. The fundamental reason for all of these changes is changing market prices in the FSU due to the removal of taxes and subsidies.

Figure 10 presents the import and export price changes by sector in the FSU. With the exception of the price of electricity, all other export prices decline. The price movements in the trade of electricity contribute positively to FSU terms of trade. All other energy commodities face a slightly deeper decline in export prices than in imports prices, and hence these commodities contribute negatively to the change in terms of trade. Recall that the trade in energy commodities accounts for about half of the FSU's total international trade. This means that the general equilibrium effects on the other sectors of the economy are significant for overall terms-of-trade movements.

Figure 10. Export and import price changes by sector in the FSU

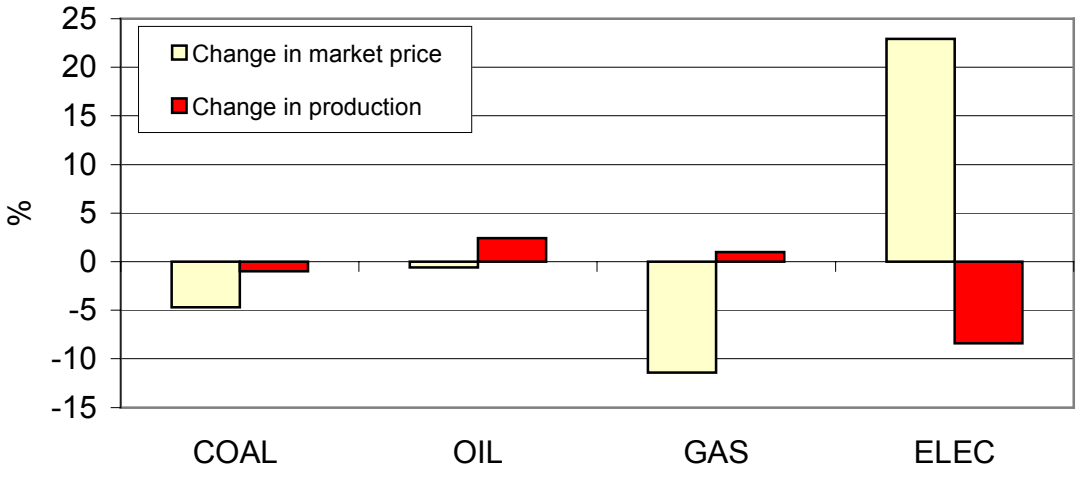


3.4 Structural effects of energy market liberalisation

Virtually all production requires energy as an intermediate input. Hence, it is logical to assume that policy changes in the energy markets will affect the entire economic structure. One way to estimate this structural change is to estimate changes in production by sector.

What does the liberalisation of energy markets imply for the production and price of energy commodities in the FSU? Figure 11 presents the percentage change in production and market price of coal, oil, gas and electricity.

Figure 11. Change in market price and production of energy commodities in the FSU



The removal of government taxes and subsidies in energy markets leads to a decline in market prices for coal and gas, and a rise in the price of electricity. There is no impact on oil prices. On the other hand, production of oil and gas increases, but production of electricity declines. These are quite natural findings keeping in mind that the production of oil and gas is currently taxed according to the GTAP database, while the electricity production is subsidised. The magnitude of market price changes for gas and electricity is significant.

In this light, the effects on the other sectors of the economy are quite limited. Table 6 presents the changes in production of all of the sectors of the economy in the different country groups.

Table 6. Change in production by sector due to liberalisation of FSU energy markets

	EU14	FIN	ACC	NAM	FSU	JAP	ASI	LAM	ENE	ROW
FOOD	0.0	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
COAL	0.0	-0.1	-0.3	-0.1	-1.0	-0.1	-0.1	0.0	0.0	0.0
OIL	-0.4	-0.6	-0.8	-2.0	2.4	-0.2	-0.3	-0.2	-0.2	-0.3
GAS	-4.1	-4.2	-2.7	-1.1	1.0	-1.4	-1.8	-1.6	-0.4	-2.7
ELEC	0.5	2.1	2.0	0.1	-8.4	0.1	0.0	0.1	0.2	1.6
GDT	-0.8	-1.8	2.1	-0.3	1.1	-0.4	-0.8	0.0	0.0	-2.2
CHEM	0.0	0.1	0.4	0.0	-0.9	-0.1	0.0	0.0	0.4	0.1
MNFS	0.0	-0.2	-0.8	0.0	0.3	0.0	0.0	0.0	0.2	0.1
TRAN	0.0	-0.1	-0.3	0.0	1.1	0.0	0.0	0.0	0.0	0.0
COMP	0.0	0.0	0.3	0.0	-0.4	0.0	0.0	0.0	0.0	0.0

The market reforms in the FSU clearly have an effect for the energy markets of the outside regions. This is especially true for gas. Gas production in the EU declines by 4%. Somewhat surprisingly, the liberalisation leads also to a substantial decline in the production of oil in North America. Finally, electricity production increases in Finland. This is not surprising considering the current large share of imports from the FSU and the large increase in the FSU market price of electricity as a result of liberalisation.

The effects are limited for other sectors of the economy. This is true for both the FSU and other regions. One could perhaps expect larger effects especially in the FSU since the changes in market prices of energy commodities are significant. In the FSU, the production of chemicals, rubber, plastic products and raw materials declines, as well as production in the composite sector. On the other hand, we see higher output of manufactured products and transport services. These effects result basically from the differences in energy-intensities of production of various sectors and the use of particular energy commodities as an intermediate input.

Liberalisation imposes a certain degree of structural change on accession countries. In the other regions, the changes are practically zero. This perhaps defies our expectations, but at the same time it is a logical finding. The share of the FSU economy of the total world economy is small, so it is logical that even large-scale reforms in the FSU might not lead to significant changes in the production structures of other regions.

These simulation results suggest it may be appropriate for the EU to promote market reforms in FSU energy markets. Such reforms could improve welfare in the EU without politically sensitive structural effects.

3.5 Further issues in energy market liberalisation

When considering any of these results, remember that the GTAP model is a static model and its results should be interpreted as indicating the change that has resulted when an economy has moved to a new steady-state equilibrium after a shock. Moreover, firms here do not make profit (indeed, it is unclear what “profits” would mean in the context of this model). Thus, it is not possible to explicitly analyse other kind of market reforms other than abolishing of government taxes. Since there are no profits, no market power and no firms in the model, a comprehensive analysis of market reforms requires additional tools.

GTAP model versions have been adapted to handle the issues above. A dynamic version of the model, like the static version, allows evaluation of the "total" change in the economy, but it further allows analysis of the path and year-to-year change to the new equilibrium. There are also versions that assume imperfect competition, providing tools to analyse changes in market environment. This is particularly important in the FSU energy market, which is so clearly dominated by agents with market power. All future real-world reforms will first and foremost impact the market power of current players. On the other hand, regional division of production at a global level is driven in the long run by comparative advantages of regions. Thus, it can be argued that the approach in the standard GTAP model well captures the long-run effects of policy changes.

One issue that can be addressed with the static GTAP model is the question of total "net" effects of market liberalisation. We assumed above that market liberalisation is a synonym for the abolition of government taxes and subsidies. If implemented, such a move would likely have widespread effects on the productivity of gas and oil extraction and the investments in the network of oil and gas distribution, etc. The following section makes the first attempt to take into account these induced effects by simulating the effect of an increase in the export capacity of oil and gas. However, a fully satisfactory analysis of the effects of energy market reforms would have to address these issues more profoundly.

4 Effects of an increase in FSU oil exporting capacity

4.1 Increased export capacity

The potential for servicing the need of oil of Western European markets with an increase of imports from the FSU oil and gas fields has been a recurring theme since the collapse of the Soviet Union.[11] Most FSU production facilities are technically obsolete and highly inefficient. The pipelines connecting the oil and gas fields to western markets are old and capacity is limited. Indeed, capacity is what currently prevents Russia from ramping up its energy exports. The situation is likely to improve in the near future as Russia is investing heavily in the export infrastructure in harbours and the pipeline grid.

The GTAP model gives several possibilities for simulating the effects of an increase in the export capacity of energy commodities. The experiment simulated in this work is one where the effective price of goods imports from the FSU is shocked through an import-augmenting "technical change."

The simulations in this work assume a uniform increase in the efficiency of imports to Finland, accession countries and the rest of the EU. While this experiment does not necessarily correspond to real-world development, it is a natural benchmark in considering the effects of an increase in the FSU's exporting capacity to Western Europe. In the first scenario, the capacity increase is assumed to solely affect exports of oil. The second assumes an increase in the efficiency of both oil and gas exports.

Figure 12 presents the welfare changes in the importing regions and in the FSU assuming 20% and 40% increases in "capacity," as defined above.

[11] The impacts of increasing gas imports have been publicly debated in Finland.

Figure 12. Welfare effects of an increase in FSU export capacity

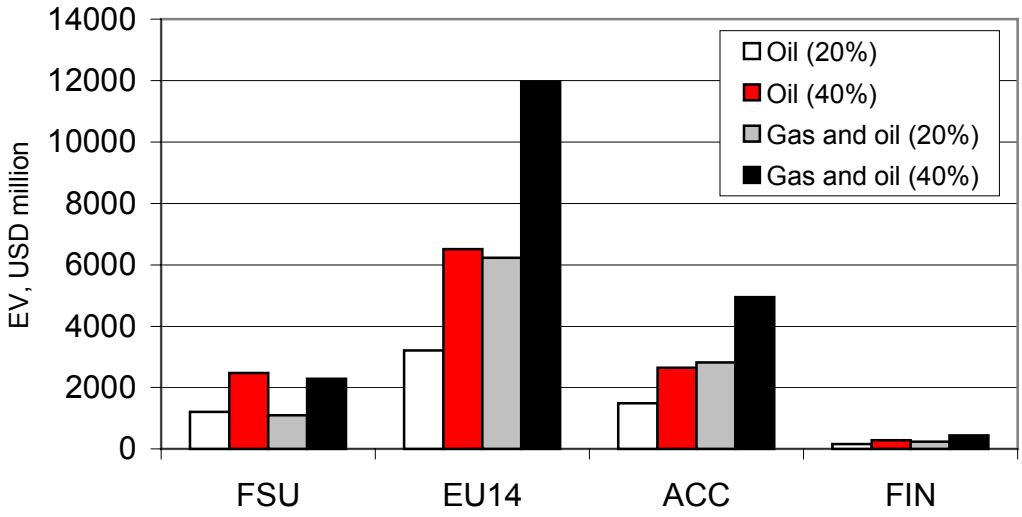


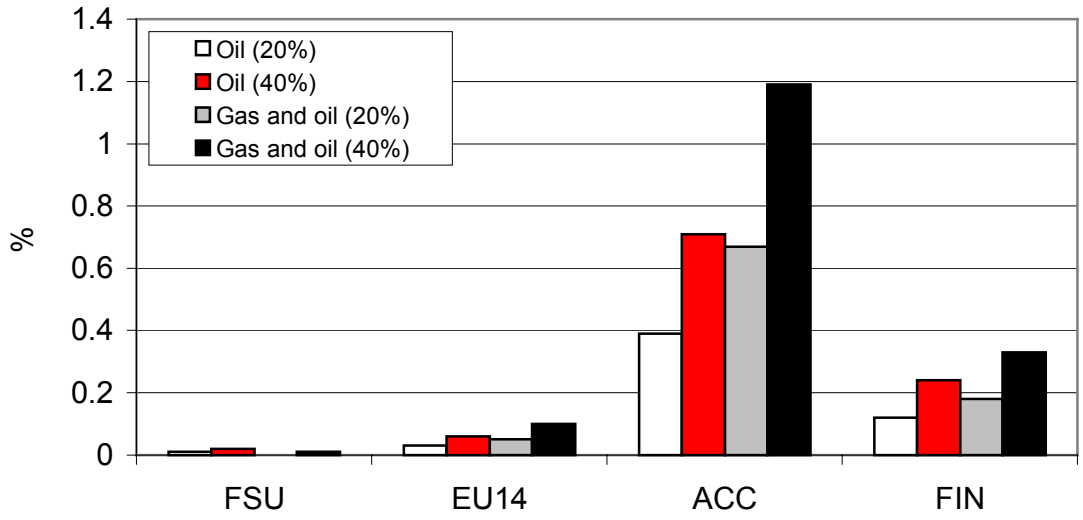
Figure 12 highlights a difference between the effects on the exporting region (the FSU) and the importing regions. It is almost irrelevant for the FSU whether the export capacity of both oil and gas or just oil is increased. In fact, if the magnitude of the increase is assumed to be 40%, the FSU gains more if the increase is limited to just the exporting of oil.

The opposite is true for the importing regions. This is because the importing regions gain as more cheap energy from the FSU becomes available (recall the EU's comparative advantage over the FSU in energy). Obviously, a shock that increases the availability of both gas and oil is more beneficial than one that just increases the availability of oil.

Perhaps the most fundamental difference between the effects of the liberalisation of the energy markets and the increase of export capacity is that the latter has a larger effect on welfare (compare Figures 4 and 12). Recalling the discussion in section 3.5, it is likely that the two changes would be interlinked in real world (the increase in the export capacity would be a form of induced technological change due to liberalisation) and the effects should be analysed together. However, if the two experiments are analysed separately, the difference between the two is largest for the FSU. The FSU loses in the liberalisation experiment as far as welfare is concerned, but the welfare change is positive in the case of increased export capacity. The reason for this finding is differences in export and import price movements (terms-of-trade effect).

Figure 13 illustrates the GDP change caused by an export capacity increase.

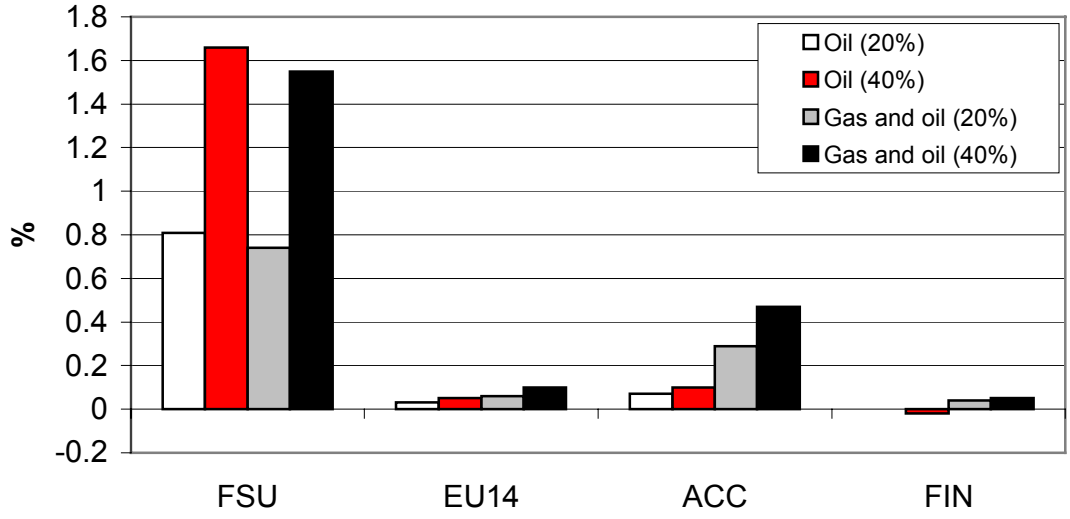
Figure 13. GDP change due to an increase in FUS export capacity



As far as aggregate economic activity is concerned, the effect of the export capacity increase is largest for the accession countries. The impact on economic activity is much more pronounced than in the liberalisation case presented in Figure 2.

Figure 14 presents the terms-of-trade effect from an export capacity increase.

Figure 14. Terms-of-trade change due to an increase in FSU export capacity



The terms-of-trade effect is strongly positive for the FSU, and smaller for importing regions. Here it seems that the relative role of sources of net welfare change varies among the regions (recall that in the liberalisation experiment the terms-of-trade effect dominated in the welfare change of every region). This is confirmed by the decomposition of the welfare change presented in Figures 15 and 16. Figure 15 corresponds to a 40% increase in oil export capacity. Figure 16 shows the decomposition where the capacity for both oil and gas exports is increased 40%.

Figure 15. Decomposition of the welfare change (oil)

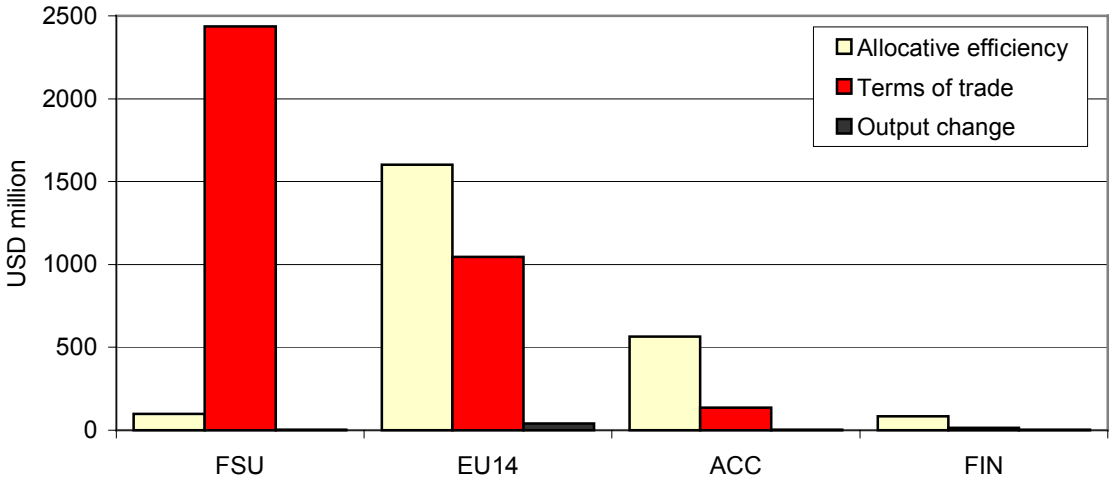
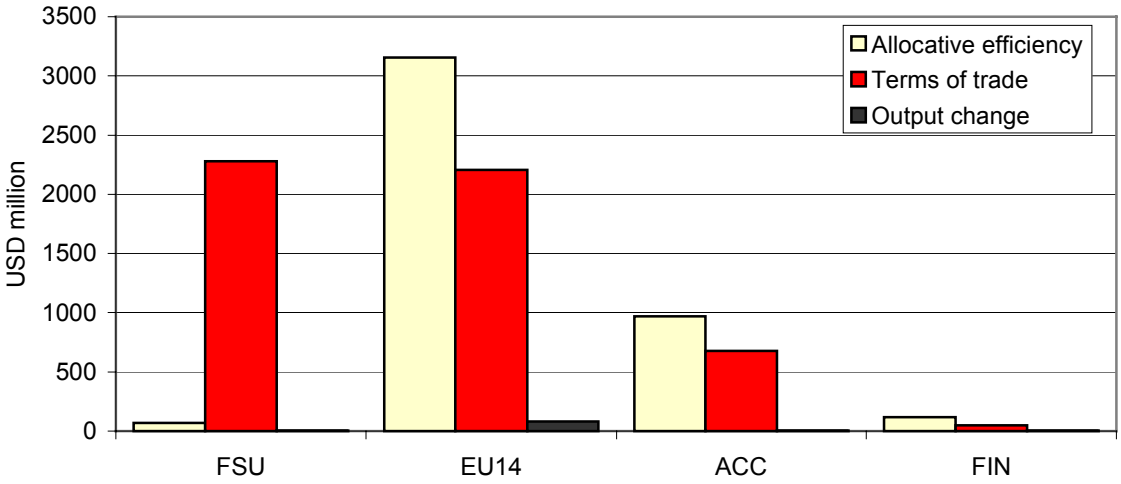


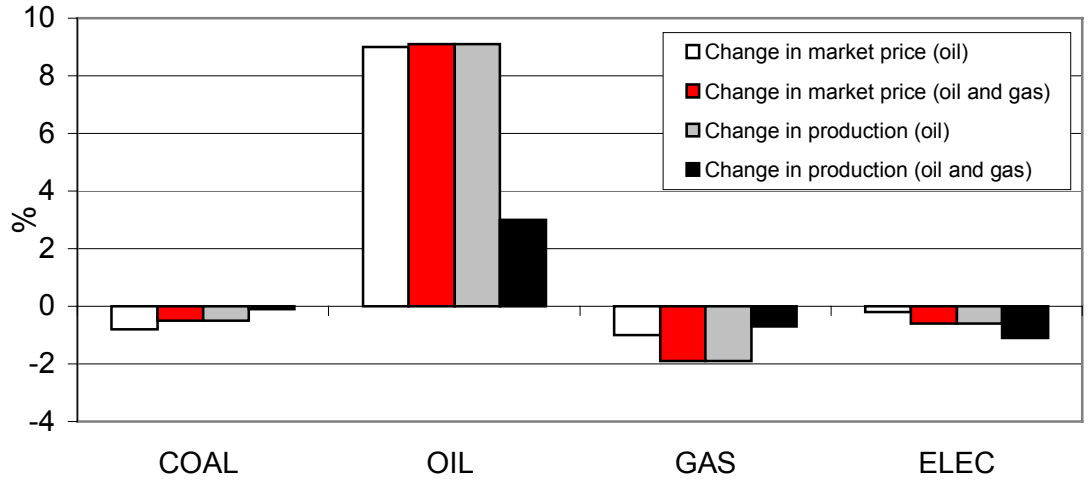
Figure 16. Decomposition of welfare change (oil and gas)



Thus, the obvious source for the improving welfare of the FSU is the terms-of-trade effect. For the importing regions, the decreasing distortions in the economy are the key to welfare gains. Also the terms-of-trade effect is important for the importing regions.

What does the increase of export capacity imply for the FSU energy markets? Figure 17 illustrates the change in market prices and production of different energy commodities as a result of the increase in export capacity of oil only and oil and gas.

Figure 17. Change in market price and production of energy commodities in the FSU



The effect is largest for the oil markets. When the capacity increase affects only the export of oil, both the market price and oil production increase by about 10%. The market price increase reflects an increased demand of energy due to the export capacity increase. If the export capacity of gas rises, the increase in oil production diminishes to just 3%, because oil and gas are substitutes for each other. The market price and production of other energy commodities declines. Even if the export capacity of gas increases, FSU gas production declines. One interpretation here is that the effect from the increase of oil export capacity dominates. Even if gas becomes less scarce in European markets, the flow of effectively cheaper oil leads to energy substitution in favour of oil.

The general equilibrium effects on the other sectors of the economy are larger when the export capacity of energy commodities increases compared to the previous liberalisation experiment (at least, in the exporting and importing regions directly affected). Table 7 presents the changes in production by sector due to the capacity increase. The change is presented in two columns for each of the regions. The left-hand side column labelled oil represents the experiment when only the capacity of oil exports increases and the second column "oil+gas" refers to capacity increases for both oil and gas.

Table 7. Change in production by sector

	EU14		**FIN**		**ACC**		**NAM**		**FSU**		**JAP**		**ASI**		**LAM**		**ENE**		**ROW**	
	oil	*oil+ gas*	oil	*oil+ gas*	oil	*oil+ gas*	oil	*oil+ gas*	oil	*oil+ gas*	oil	*oil+ gas*	oil	*oil+ gas*	oil	*oil+ gas*	oil	*oil+ gas*	oil	*oil+ gas*
FOOD	0.0	*-0.1*	-0.3	*-0.4*	-0.2	*-0.3*	0.0	*0.0*	0,1	*0.2*	0.0	*0.0*	0.0	*0.0*	0.0	*0.1*	0.0	*0.0*	0.0	*0.1*
COAL	0.0	*0.1*	-0.1	*0.0*	-0.2	*-0.2*	0.0	*0.1*	-0.2	*-0.1*	0.0	*0.1*	0.0	*0.1*	0.0	*0.1*	0.1	*0.2*	0.0	*0.1*
OIL	-3.4	*-3.3*	-6.8	*-6.9*	-7.4	*-7.7*	-1.4	*-1.4*	3.0	*2.0*	-1.3	*-1.3*	-1.6	*-1.6*	-1.1	*-1.1*	-1.0	*-1.0*	-1.8	*-1.8*
GAS	-0.3	*-12.3*	-0.4	*-8.1*	-0.4	*-9.7*	0.0	*-2.3*	-0.4	*-0.7*	0.0	*-3.2*	-0.1	*-4.0*	-0.1	*-3.7*	0.2	*-0.8*	-0.1	*-6.8*
ELEC	0.0	*0.3*	0.0	*0.5*	0.4	*1.1*	0.0	*0.0*	-1.0	*-1.1*	0.0	*0.1*	0.0	*0.1*	0.0	*-0.2*	0.2	*0.4*	0.2	*0.5*
GDT	0.0	*0.3*	-1.0	*0.3*	0.4	*3.5*	0.0	*0.0*	-0.3	*-0.5*	0.1	*0.4*	0.0	*0.4*	0.0	*0.0*	0.7	*0.9*	0.2	*0.4*
CHEM	0.2	*0.2*	2.7	*2.5*	2.4	*2.9*	0.2	*0.2*	-4.6	*-4.6*	-0.2	*-0.2*	0.0	*0.0*	-0.1	*-0.1*	2.0	*2.0*	0.3	*0.5*
MNFS	-0.1	*-0.1*	-0.8	*-0.9*	-1.9	*-3.0*	0.0	*0.0*	-0.3	*-0.1*	0.0	*0.0*	0.0	*0.0*	0.1	*0.1*	1.5	*1.4*	0.4	*0.7*
TRAN	0.0	*-0.1*	-0.1	*-0.2*	-0.6	*-1.0*	0.0	*0.1*	-0.1	*0.0*	0.0	*0.0*	0.0	*0.0*	0.1	*0.1*	0.2	*0.1*	0.1	*0.1*
COMP	0.0	*0.0*	0.1	*0.1*	0.5	*1.0*	0.0	*0.0*	0.2	*0.2*	0.0	*0.0*	0.0	*0.0*	0.0	*0.0*	-0.4	*-0.3*	-0.1	*-0.1*

The production of oil declines in the other regions[12]. If the export capacity of gas increases, the production of gas in the other regions also decreases. The decrease in this case is most notable in the EU. The fundamental source of these effects is the increased supply of cheaper energy from the FSU resulting in substitution of other sources.

Outside the energy sectors, the sector most affected in the FSU, EU, Finland and accession countries is production of chemicals, rubber, plastic products and raw materials. Production in this sector is energy-intensive and oil especially is a major intermediate factor of production. Thus, the decreasing relative price of imported energy from the FSU provides a comparative advantage for this sector in EU14 and in Finland. The same effect works oppositely for production pf chemicals, rubber, etc. in the FSU. The market price of oil increases in FSU markets (see Figure 18 above).

For obvious reasons, the effect of a capacity increase is much more limited outside regions importing FSU energy. It can be argued that the effect for e.g. production of gas in North America and Latin America, as well as production of chemicals etc. in the Energy Producing Region (ENE), is quite significant, keeping in mind that the effect is transmitted solely through trade linkages between regions.

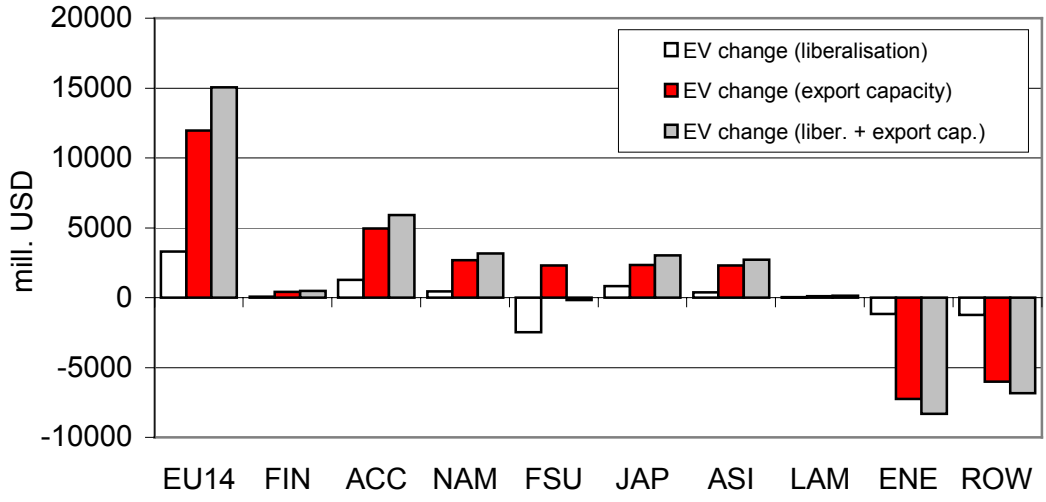
4.2 Liberalisation of energy markets and increases in export capacity: The case of induced technological change

As discussed in section 3.5, it is possible that market reforms in FSU energy markets may have widespread effects. Indeed, it is quite possible that market liberalisation and the introduction of a more competitive market environment would lead to improved, cost-efficient production methods that, in turn, would lead to productivity gains. It is further possible that more would be invested in the currently outdated network for oil and gas distribution. These effects are examples of "induced effects" from market liberalisation. A comprehensive study about these effects would merit a separate work, but as a first attempt in this direction the experiments of previous sections are combined to illustrate what the GTAP model suggests about the total net effects.

Figure 18 illustrates the welfare effects of an experiment when all of production taxes and subsidies are removed (as in the experiments of section 3 and as in the export capacity increase of 40 % simulated in section four). This is an ad hoc thought exercise and the results should not be taken too seriously. A satisfactory analysis of induced effects should take into account e.g. the likely increase in the productivity of gas an oil production. Figure 19 compares the welfare effects of our "basic" liberalisation experiment in section 3 and the welfare effects of the export capacity increase from section 4 to the effects of this combined liberalisation and increase in export capacity experiment.

[12] Due to the way the database is constructed, some sectors that do not actually exist in a particular region show a positive amount of production in the database (for example, production of natural gas in Finland). These are merely residuals from the fitting of several sources into a single GTAP database.

Figure 18. Welfare effects of different experiments



The primary finding about the effects of different experiments is apparent from Figure 19. The driving force of welfare changes is the change in export capacity. It should be emphasised again that the 40% shock in the latter is totally ad hoc without any links to the existing literature. Our point here is not determination of the exact change in welfare, but testing the notion that, when market reforms occur, the largest positive effect may be indirect and come in the form of induced changes such as an increase in export capacity.

Figure 18 clearly shows that when such effects are taken into account, the welfare gain of regions importing energy increases and the net effect for the FSU improves. Other regions exporting energy also suffer greater losses. The intuition behind this is probably the fact that the more energy from the FSU becomes available to the markets of importing regions, the more it substitutes energy from other sources.

5 Conclusions

This work has analysed possible developments in FSU energy markets. The current real-world situation is that all energy markets in the FSU are heavily influenced by government interventions and the market environment is uncompetitive and inefficient. Energy exports, especially oil and gas, are also important sources of government revenues.

Reforms in the FSU energy markets are often seen as crucial for the economic development of this region. Since the region is a major energy exporter and the location of the world's largest known gas reserves, the reforms are also believed to be important for outside regions. The EU imports large volumes of oil and gas from the FSU. Finland is particularly dependent on the exports of gas and electricity from the FSU (which in practice means Russia).

While these issues and the effects of possible reforms in the FSU have been widely discussed in the literature, the use of CGE models has been limited. This work contributes to this area with two experiments simulated with the GTAP model. The main experiment is one where the effects of a total market liberalisation are assumed. This involves abolishing all government interventions related to production and trade of energy commodities. The

second experiment simulates an increase in the export capacity of oil and gas from the FSU to the EU (EU, accession countries and Finland).

The purpose of this work is to provide some preliminary results on the possible effects of market reforms and also identify areas for future work. While the results are not to be taken literally, the general direction of the results emerging from the simulations is surprisingly clear. The deeper the reforms and market liberalisation in the FSU, the more the EU gains.

The liberalisation of FSU energy markets is beneficial for the EU and Finland. For the FSU itself, removal of government taxes and subsidies seems to incur welfare losses. The overall welfare effects of the liberalisation are small in every region and the structural effects on the economies are limited. This is true even for the FSU, a somewhat counter-intuitive finding. The primary source for the welfare effects is the terms-of-trade movements. As expected, reforms reduce the distortions in the economies. However, the decline in the ratio of export to import prices is so large for the FSU that the net effect on welfare is negative. It should be kept in mind that this is a result obtained from a static model that ignores dynamic effects, which are probably the effects determining the final effects of the market reforms in the long run.

As a result, the "induced effects" of the liberalisation deserve consideration. This work makes the first step in this direction by including an experiment in which the export capacity of oil and gas from the FSU to western markets is assumed to increase. The effects in this case are larger than the effects of the market liberalisation itself. A capacity increase benefits both the FSU and the EU. If the two experiments are combined based on the assumption that market liberalisation leads to investments in the oil and gas networks, the EU experiences an even larger welfare gain. Thus, an adequate analysis must take into account dynamic aspects of energy market reforms.

The lesson from the EU's perspective is clear. The EU should encourage liberalisation and market reforms in FSU energy markets to take advantage of the comparative advantage that the FSU has in energy. Notably, cheaper FSU energy can be imported both in the form of pure energy products or in the form of energy-intensive commodities. The worst-case scenario for European economies is one where the FSU artificially loses its natural competitive advantage in energy.

For the FSU, the primary message of this work is that all aspects of market reform have to be taken into account when evaluating their effects. The model suggests that the most important issue for FSU welfare is the capability to export the energy commodities into the European markets. In the real world, this is probably not a separate issue but rather relates to the overall market environment and functioning of FSU energy markets.

Appendix 1. Raising the gas price in the FSU

Russia is currently engaged in serious WTO membership negotiations. Officially, Russia says it wants to join the organisation soon. In fact, there are several intractable issues likely to prolong the negotiations. One of the thorniest issues arises from EU claims about Russian energy markets. EU representatives argue that Russia's low domestic gas rates and extremely cheap electricity mean energy-intensive industrial exports such as aluminium and steel are indirectly subsidised to an extent that it constitutes unfair competition.[13]

This claim of unfair competition, especially in the light of the above discussion, seems hard to justify. At worst, it constitutes mere protectionism. Nevertheless, assuming the argument is valid, let's consider what could happen if Russia complied with EU demands. What are the economic consequences for Russia and the EU if domestic energy prices are raised in Russia? The GTAP model allows us to estimate the effects of tax increases on different regions. Although the current database makes no distinction between Russia and the other regions of the FSU, findings for the FSU should be similar to the effects of policy changes in Russia.[14]

Here, we assume that the FSU raises domestic market price for gas by increasing production taxes. Figure 20 presents the tax increase and the resulting effect on market prices for all major energy commodities (coal, oil, gas, electricity) in the FSU.

Figure 1a. The effect of increasing the production tax on FSU market prices for energy commodities

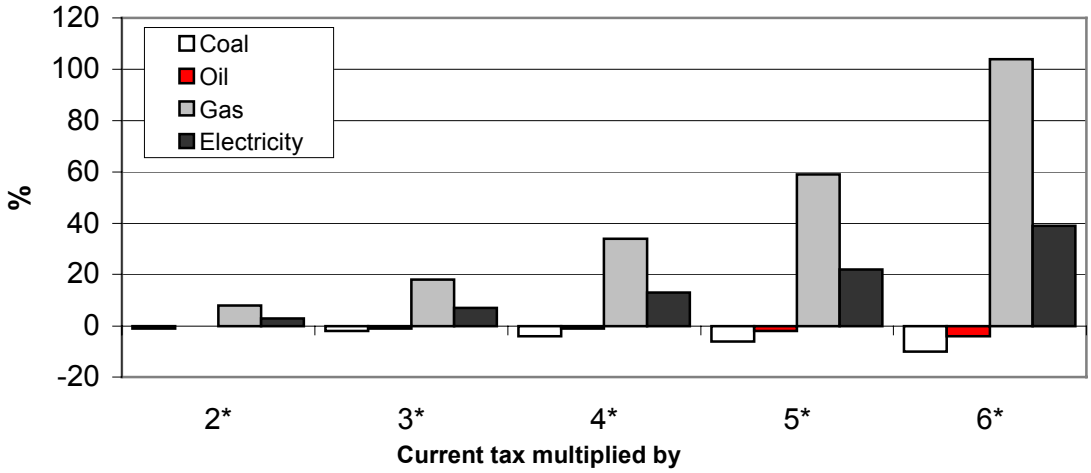


Figure 1a shows that, if the goal is to double the current market price level of gas in the FSU, the current production tax needs to multiplied six times. This would also lead to an approximately 40% increase in the market price of electricity. The prices of coal and oil show a small decline.

How does the tax increase affect the energy markets of the EU? Figure 2a shows the effects on EU market prices for the four energy commodities.

[13] EU trade commissioner Pascal Lamy remarked in IHT on May 29, 2002, "A key issue for the EU is the dual pricing of energy products. The cost of energy in Russia is artificially low. Natural gas costs as little as one-sixth of the world price. The net effects of low prices are an annual subsidy of around $5 billion for Russian industry. Manufacturers are able to export goods at prices that are unfairly low. The issue is too important for the EU to ignore."

[14] Russia is by far the largest economy of the FSU. Its role in energy markets dominates the current database.

Figure 2a. The effect of increasing the production tax on EU market prices for energy commodities

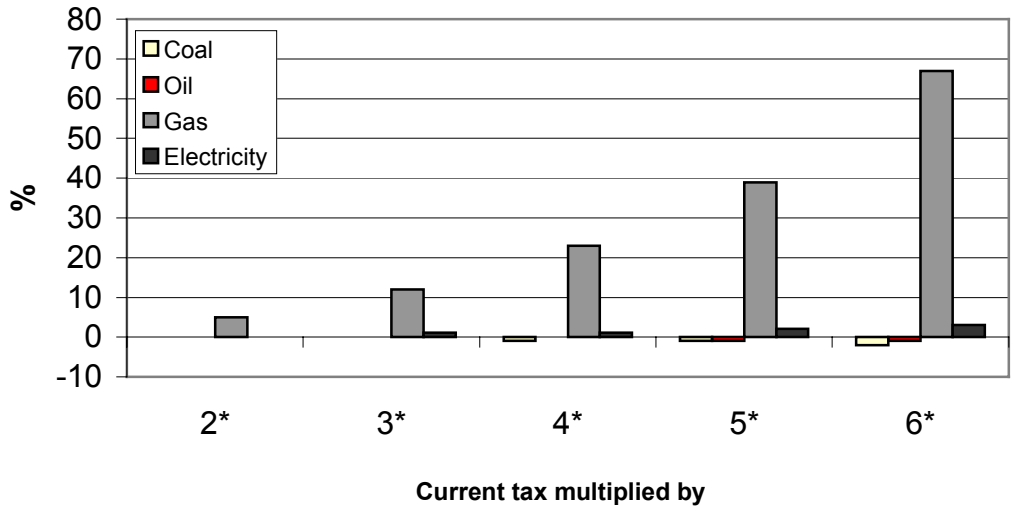
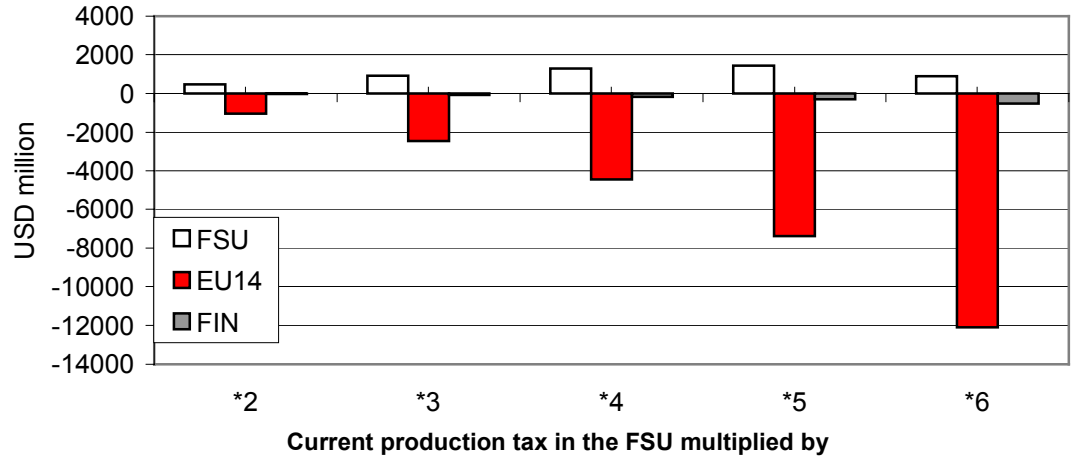


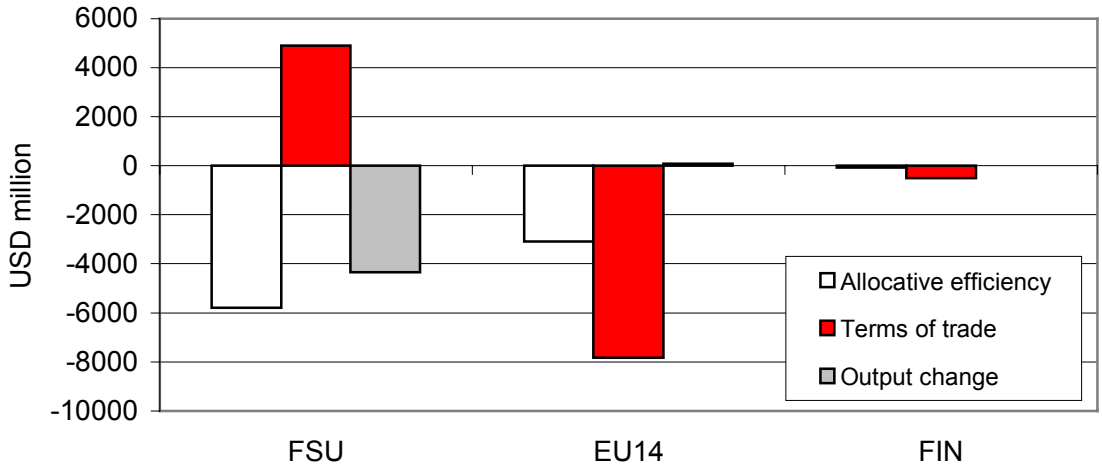
Figure 2a shows that the tax increases lead to higher EU prices. The increase in gas price is significant. The effect on the gas price in the EU is an intuitive result of the heavy dependence of this region on gas imported from the FSU. Thus, when the internal price of gas in the FSU, the export price also increases leading to a significant upward pressure on EU market prices. This fact has important implications for the welfare effects of FSU policy changes in the EU. Figure 3a illustrates the welfare effects of production tax (and consequent price) increases for FSU, EU and Finland.

Figure 3a. The effect of increasing the production tax on FSU welfare



The higher the production tax, the larger the welfare loss is for the EU. The FSU itself experiences a small increase in welfare and Finland, like the rest of the EU, loses. A tax increase is detrimental for the EU in all of the aspects used in this work. The inefficiencies arising from misallocation of factors of production increase (allocative efficiency effect) and the terms of trade deteriorate severely. Figure 4a illustrates the sources of welfare changes for the three regions in the case where the FSU market price for gas price is doubled (production tax multiplied by six).

Figure 4a. Decomposition of the welfare change



An increase in taxes usually creates distortions in the economy, and the FSU in no exception in this respect. A large increase in gas production tax is detrimental as far as output change and allocative efficiency are considered. However, in the FSU's case, the change in the terms of trade is so positive that it dominates. The net welfare change in a static environment is also positive. For the EU, the tax increase leads to only negative effects. It increases distortions and leads to a significant deterioration of the terms of trade. Hence, an increase in FSU energy prices has a dual negative role for the EU. It not only forces the EU to pay more for energy, it also subsidises domestic energy production relative to the no-distortion case. This creates a welfare loss due to the factors of production allocated to these activities that could be used more productively elsewhere in the economy. The policy implications here should not be ignored.

In conclusion, Table 1a shows the general equilibrium effects on other sectors of the economy. The figures correspond to the case of doubled market price of gas in the FSU.

Table 1a. Change in production by sector

	Change in production of different sectors of the economy									
	EU14	FIN	ACC	NAM	FSU	JAP	ASI	LAM	ENE	ROW
FOOD	-0.1	0.0	0.0	-0.1	3.4	-0.1	0.0	-0.2	0.0	-0.1
COAL	-0.6	-0.7	0.0	-0.5	-0.3	-0.6	-0.5	-0.4	-0.3	-0.5
OIL	-0.6	-0.5	-0.3	-0.5	2.8	-0.4	-0.5	-0.5	-0.2	-0.6
GAS	12.1	13.0	8.6	5.5	-20.5	5.7	7.6	5.9	2.7	8.9
ELEC	0.0	1.0	0.0	0.2	-11.1	-0.4	-0.1	0.9	-1.0	0.8
GDT	-0.3	-1.6	-7.8	0.1	-6.9	-0.9	-1.0	0.3	-0.6	0.5
CHEM	0.0	1.5	-0.9	0.0	-1.9	0.0	0.1	-0.1	0.4	-0.4
MNFS	0.0	-0.3	3.3	-0.2	4.2	-0.1	-0.2	-0.2	0.5	-0.8
TRAN	-0.1	0.4	1.4	-0.4	7.9	-0.2	-0.2	-0.2	0.0	-0.3
COMP	0.0	-0.1	-1.4	0.0	-0.6	0.0	0.1	0.1	-0.2	0.2

The most notable effect is the increase of gas production in outside regions. The FSU tax increase benefits EU gas production. The same is true for production in North America (and indeed in every region that produces gas). These findings are intuitive. It is clear that when the price of gas in the FSU increases, this gives an advantage for the production of gas in other regions leading to increased output levels. The overall effects outside the FSU

are largest in the accession countries, where, for example, the production of manufactures increases. The taxing of gas in the FSU benefits the production of food, oil, manufactured products and transports. A counter-intuitive finding is that a large increase in the gas price does not result in a large-scale fuel substitution. FSU oil production increases as expected, while the effects on production of other energy commodities is small in other regions.

Market liberalisation vs. taxation: The effects on the EU and FSU

The first and main experiment of this work considered the effects of energy market liberalisation in the FSU, or more precisely, a complete (and somewhat unrealistic) tax exemption case whereby all taxes related to production and international trade of energy commodities was simulated. The second experiment simulated an increase of export capacity of oil and gas. The final simulation considered the effects of increasing taxation on gas production in order to raise the market price of gas in the FSU. The last experiment responds to EU demands that the FSU (i.e. Russia) should raise its domestic gas prices to avoid unfair competition from its energy-intensive sectors against the EU. We now consider the implications of the three experiments relative to each other. Is there any ground for the EU demands or should it encourage the FSU to follow the path of market liberalisation for its own selfish interests? Figure 5a illustrates the welfare effects of the three experiments on FSU, EU and Finland.

Figure 5a. Welfare change in different experiments

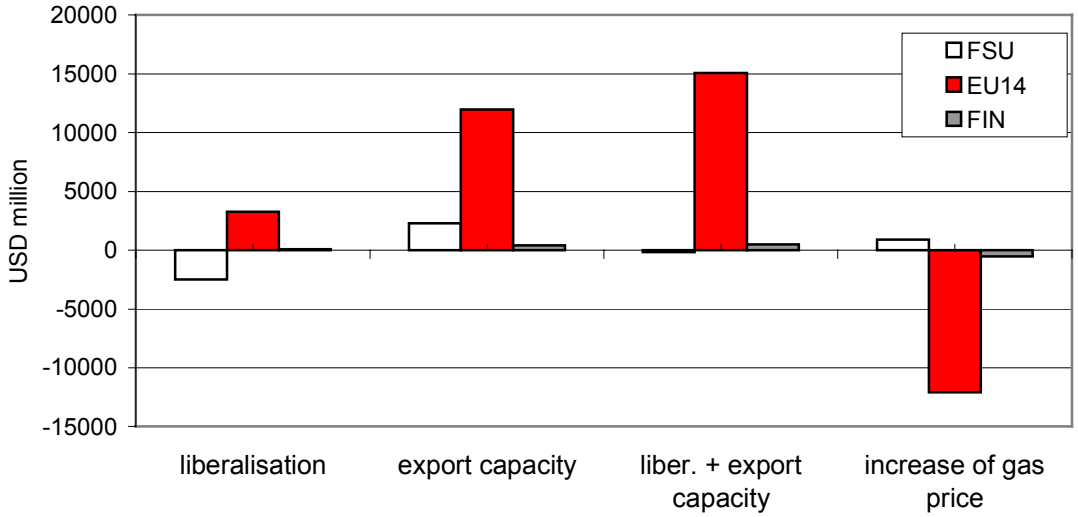


Figure 5a clearly shows which approach best serves the interests of the EU. The more liberal the FSU energy market, the greater the welfare increase in the EU. As discussed above, an increase in the export capacity is arguably a form of "induced change" resulting from an overall liberalisation of FSU energy markets. However, an increase in gas prices in the FSU is distinctly against the economic interests of EU.[15]

[15] The results are largely based on the assumption that a rise in the domestic market price of gas in the FSU leads to higher export prices. The advocates of the price increase are usually looking for a domestic price increase that leaves the export prices untouched. This argument is based on the current cross-substitution of domestic prices by profits from exports.

The intuition is clear. The FSU has a comparative advantage in the production of energy commodities. The better the EU can take advantage of this by importing cheap energy from the FSU, the more it gains in economic terms. The claims of high-ranking EU officials about the "unfair" competition from the FSU are thus not only economically hard to justify but possibly against the economic interests of the EU. Other issues such as security-related concerns are outside of the scope of this work.

The demand for increased energy prices in the FSU is often justified by the temporary costs related to the structural change in the EU that result if the FSU is allowed to take advantage of its cheap energy. This claim is a natural one from the perspective of political economics even though it does not survive a thorough economical analysis. What is interesting is that the GTAP model suggests that even this effect is not as straightforward result as it may sound. Table 2a presents the change in production by sector under three experiments: the market liberalisation, export capacity increase and gas price increase. The change in production structure appears smallest in the market liberalisation case.

Table 2a. Change in production by sector

	Sectoral changes in production		
	Liberalisation	Export capacity	Gas price increase
FOOD	0	-0.1	-0.1
COAL	0	0.1	-0.6
OIL	-0.4	-3.3	-0.6
GAS	-4.1	-12.3	12.1
ELEC	0.5	0.3	0
GDT	-0.8	0.3	-0.3
CHEM	0	0.2	0
MNFS	0	-0.1	0
TRAN	0	-0.1	-0.1
COMP	0	0	0

Appendix 2. Aggregation of sectors and regions

Sectors in the experiments of this work

```
FOOD          & Food and food processing
COAL          & Coal
OIL           & Oil
GAS           & Gas
ELEC          & Electricity
GDT           & Gas distribution
CHEM          & Raw materials and chemical prd
MNFS          & Manufactured products
TRAN          & Transport
COMP          & Rest of the sectors
```

Mapping of sectors

```
pdr             Paddy rice                      & FOOD
wht             Wheat                           & FOOD
gro             Cereal grains nec               & FOOD
v_f             Vegetables, fruit, nuts         & FOOD
osd             Oil seeds                       & FOOD
c_b             Sugar cane, sugar beet          & FOOD
pfb             Plant-based fibers              & FOOD
ocr             Crops nec                       & FOOD
ctl             Cattle,sheep,goats,horses       & FOOD
oap             Animal products nec             & FOOD
rmk             Raw milk                        & FOOD
wol             Wool, silk-worm cocoons         & FOOD
for             Forestry                        & FOOD
fsh             Fishing                         & FOOD
col             Coal                            & COAL
oil             Oil                             & OIL
gas             Gas                             & GAS
omn             Minerals nec                    & CHEM
cmt             Meat: cattle,sheep,goats,horse  & FOOD
omt             Meat products nec               & FOOD
vol             Vegetable oils and fats         & FOOD
mil             Dairy products                  & FOOD
pcr             Processed rice                  & FOOD
sgr             Sugar                           & FOOD
ofd             Food products nec               & FOOD
b_t             Beverages and tobacco products  & FOOD
tex             Textiles                        & MNFS
wap             Wearing apparel                 & MNFS
lea             Leather products                & MNFS
lum             Wood products                   & MNFS
ppp             Paper products, publishing      & MNFS
p_c             Petroleum, coal products        & CHEM
crp             Chemical,rubber,plastic prods   & CHEM
nmm             Mineral products nec            & CHEM
i_s             Ferrous metals                  & CHEM
nfm             Metals nec                      & CHEM
fmp             Metal products                  & MNFS
mvh             Motor vehicles and parts        & MNFS
otn             Transport equipment nec         & MNFS
ele             Electronic equipment            & MNFS
ome             Machinery and equipment nec     & MNFS
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omf             Manufactures nec                & MNFS
ely             Electricity                     & ELEC
gdt             Gas manufacture, distribution   & GDT
wtr             Water                           & COMP
cns             Construction                    & COMP
trd             Trade                           & COMP
otp             Transport nec                   & TRAN
wtp             Sea transport                   & TRAN
atp             Air transport                   & TRAN
cmn             Communication                   & COMP
ofi             Financial services nec          & COMP
isr             Insurance                       & COMP
obs             Business services nec           & COMP
ros             Recreation and other services   & COMP

osg             PubAdmin/Defence/Health/Educat  & COMP
dwe             Dwellings                       & COMP
```

Regions in the experiments of this work

```
EU14          & Other current EU countries
FIN           & Finland
ACC           & Accession Countries
NAM           & North America
FSU           & Former Soviet Union
JAP           & Japan
ASI           & Developing countries of Asia
LAM           & Developing countries of L.Am
ENE           & Oil producing countries
ROW           & Rest of the world
```

Mapping of sectors

```
aus             Australia                       & ROW
nzl             New Zealand                     & ROW
chn             China                           & ASI
hkg             Hong Kong                       & ASI
jpn             Japan                           & JAP
kor             Korea                           & ASI
twn             Taiwan                          & ASI
idn             Indonesia                       & ASI
mys             Malaysia                        & ASI
phl             Philippines                     & ASI
sgp             Singapore                       & ASI
tha             Thailand                        & ASI
vnm             Vietnam                         & ROW
bgd             Bangladesh                      & ROW
ind             India                           & ASI
lka             Sri Lanka                       & ROW
xsa             Rest of South Asia              & ROW
can             Canada                          & NAM
usa             United States                   & NAM
mex             Mexico                          & ENE
xcm             Central America, Caribbean      & ROW
col             Colombia                        & ROW
per             Peru                            & ROW
ven             Venezuela                       & ENE
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xap             Rest of Andean Pact             & ROW
arg             Argentina                       & LAM
bra             Brazil                          & LAM
chl             Chile                           & LAM
ury             Uruguay                         & ROW
xsm             Rest of South America           & ROW
aut             Austria                         & EU14
bel             Belgium                         & EU14
dnk             Denmark                         & EU14
fin             Finland                         & FIN
fra             France                          & EU14
deu             Germany                         & EU14
gbr             United Kingdom                  & EU14
grc             Greece                          & EU14
irl             Ireland                         & EU14
ita             Italy                           & EU14
lux             Luxembourg                      & EU14
nld             Netherlands                     & EU14
prt             Portugal                        & EU14
esp             Spain                           & EU14
swe             Sweden                          & EU14
che             Switzerland                     & ROW
xef             Rest of EFTA                    & ROW
hun             Hungary                         & ACC
pol             Poland                          & ACC
xce             Rest of Central European Assoc  & ACC
xsu             Former Soviet Union             & FSU
tur             Turkey                          & ROW
xme             Rest of Middle East             & ENE
mar             Morocco                         & ROW
xnf             Rest of North Africa            & ROW
bwa             Botswana                        & ROW
xsc             Rest of SACU (Namibia,RSA)      & ROW
mwi             Malawi                          & ROW
moz             Mozambique                      & ROW
tza             Tanzania                        & ROW
zmb             Zambia                          & ROW
zwe             Zimbabwe                        & ROW
xsf             Other Southern Africa(Ang,Maur  & ROW
uga             Uganda                          & ROW
xss             Rest of Sub-Saharan Africa      & ROW
xrw             Rest of World                   & ROW
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Editor-in-Chief **Iikka Korhonen**

Bank of Finland
Institute for Economies in Transition BOFIT
PO Box 160
FIN-00101 Helsinki

Phone: +358 9 183 2268
Fax: +358 9 183 2294
Email: bofit@bof.fi

www.bof.fi/bofit