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AN ECONOMY-WIDE ANALYSIS OF AN INCREASE IN ENERGY PRICES IN RUSSIA: RELEVANCE OF THE NESTING STRUCTURE FOR OUTPUT EFFECTS

by

Anton Orlov[1], Harald Grethe[2], Scott McDonald[3]

Abstract

The Russian economy is very energy intensive. The improvement of energy efficiency is one of the most important political issues. One of the reasons for the low energy efficiency in Russia is the low domestic price level for energy resources. Amongst other policy reforms, the Russian government aims to liberalize the energy markets in the long run. This paper provides an assessment of the economy-wide effects of an increase in prices for some energy goods. We extend the single country CGE model "SMOD" by incorporating energy substitution into the model as well as perform a sensitivity analysis with regard to nesting structure and elasticities of substitution between capital and energy.

Keywords: energy efficiency, energy substitution, CGE, nesting structure, Russia

[1] PhD Student University of Hohenheim
[2] Professor, Agricultural and Food Policy Group, University of Hohenheim
[3] Professor, Oxford Brookes University

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An Economy-Wide Analysis of an Increase in Energy Prices in Russia: Relevance of the Nesting Structure for Output Effects

1. Introduction

Russia is one of the largest energy producers and exporters in the world. Therefore, energy sectors play an important role for the whole Russian economy; however, Russia is not only a large energy producer, but also a large energy consumer. The Russian economy is very energy intensive and energy efficiency is low. Among the reasons for the high energy intensity are the structure of the economy, low domestic prices for energy resources, climatic conditions and outdated technologies *(Kulagin, 2008).* Because of the administrative price regulation, the domestic energy prices in Russia are relatively lower than in other countries *(EIA, 2008).*

The improvement of energy efficiency and the increase of energy production are the main goals of the current Russian energy strategy up to 2030. According to this energy strategy, the Russian government is considering to liberalize energy markets in the long run, which is expected to play an important role in improving energy efficiency in the Russian economy *(MERF, 2009).*

The liberalization of the energy sectors in Russia implies an increase of prices for some energy commodities. The objective of this study is to analyze the economy-wide effects of an increase of energy prices in Russia in a stylized way. Therefore, we simulate an elimination of tax rebates for the use of coal and petroleum products for all sectors. The second objective of this study is to show the implications of the nesting structure of energy goods and the magnitude of substitution elasticities between capital and energy goods.

The macro-economic effects of energy policies are important in Russia because of the crucial role of the energy sector for its entire economy. Therefore, we use a single country CGE model "SMOD[4] "*(McDonald, 2010)* based on version 7 of the GTAP database. In addition, we extend this model and incorporate substitution possibilities between capital and energy goods.

[4] SMOD is representation of a single country model based on the GLOBE model. It uses all the intra regional transactions data derived from GTAP for the GLOBE model but simplifies the trade relations by collapsing the trade accounts to a single trade partner.

2. Energy Sectors in Russia

2.1 Importance of Energy Sectors in Russia

Russia has the largest natural gas reserves, the second largest coal reserves and eighth largest oil reserves in the world. Russia is also the world's largest exporter and producer of natural gas and the second largest oil exporter and producer *(EIA, 2008)*. The share of mineral products made up approximately 65 % of Russia's total export revenues in 2008 *(FSSS, 2009)*.

According to version 7 of the GTAP database, the share in total export value amounts 32 % for oil, 9 % for gas and 7 % for petroleum coal products (Table 1).

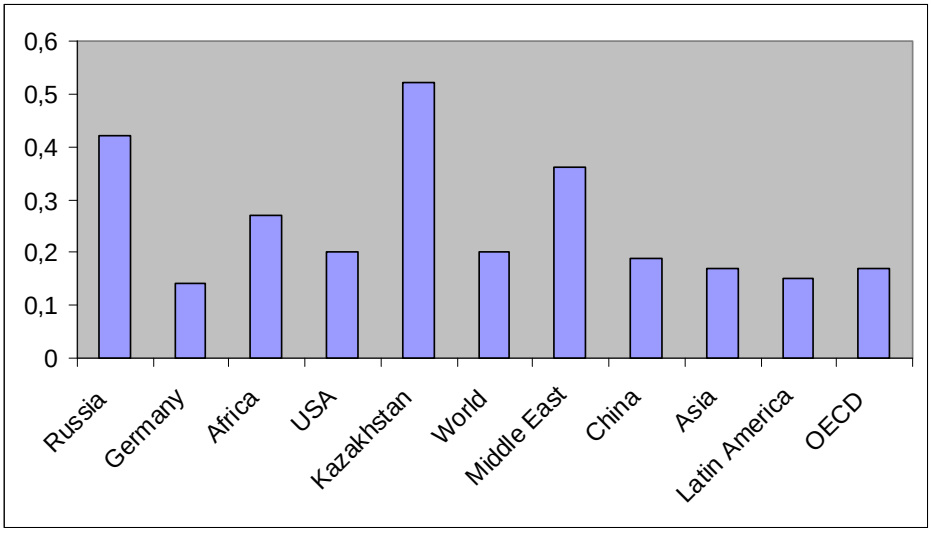
Table 1: Shares in the Total Export and Import Value (%)

	Export value	Import value
Agriculture	2	4
Coal	1	1
Oil	32	0
Gas	9	0
Minerals	1	1
Food products	2	9
Textiles	1	7
Petroleum coal products	7	0
Heavy manufacturing	27	22
Light manufacturing	5	32
Electricity	0	0
Gas manufacture	1	0
Water	0	0
Construction	1	3
Trade	7	9
Services	3	11
Total	100	100

Source: own calculations based on the GTAP 7 database

Nevertheless, Russia is not only a large producer of energy commodities, but also a large energy consumer. In Figure 1 different countries are compared with respect to the energy intensity, measured in tons of oil equivalent, to their GDP. Figure 1 demonstrates that the Russian economy is very energy intensive. For example, Russia needs twice as much energy to produce one unit of GDP compared to the USA and Asia.

Figure 1: Comparison of Energy Intensity, 2007 (tons of oil equivalent/thousand $ GDP in 2000 ppp)



Source: IEA, 2009

The Russian energy sectors are strongly related. For example, electricity production is the largest domestic consumer of coal, gas and gas manufacture. The share of electricity in the total consumption costs are 67 % for coal, 64 % for gas and 42 % gas manufacture (Annex Table A1). The petroleum production sector is the largest consumer of oil with a share of 98 % of the total consumption costs. In addition, the heavy manufacturing sector is the largest consumer of electricity among all sectors with a share of about 30 % of the total domestic consumption costs.

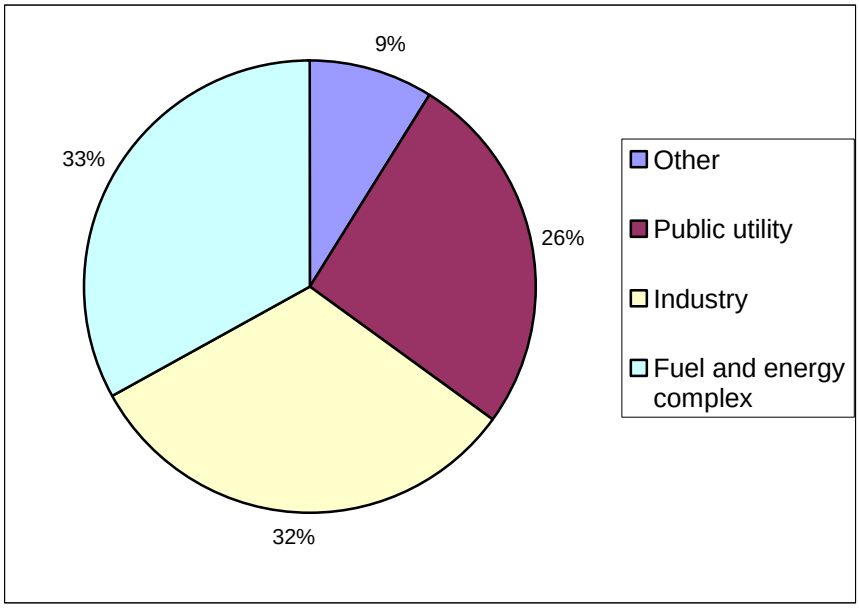
2.2 Energy Efficiency in Russia

Energy efficiency in Russia is very low. The main reasons for this are low domestic prices for energy resources, environmental and climatic conditions, the economic structure and outdated equipments *(Kulagin, 2008).*

The inefficient use of energy resources has negative economical and ecological consequences. Improving Russia's energy efficiency has become one of the country's most important political issues. Russia expects large benefits from improvements in its energy efficiency. According to an estimation from the Center for Energy Efficiency, Russia could save about 45 % of its total primary energy consumption if it were more efficient *(Sargsyan and Gorbatenko, 2008).* National statistics show that in 2002, the average age of industrial facilities and equipment was 20 years. The replacement of these facilities is crucial for the development of Russia's industry *(APEC, 2006).* Figure 2 shows the shares of the energy

saving potential in different sectors of Russia. The energy saving potential is quite large in all sectors, particularly in the industry and energy producing sectors.

Figure 2: Energy Saving Potential According to Russian Energy Strategy up to 2020



Source: Kulagin, 2008

2.3 Energy Policy in Russia

Due to the administrative price regulation, domestic energy prices in Russia are relatively low compared to other countries. For instance, the prices for petroleum and electricity are about 50 % of the average prices in the EU, and domestic gas prices in Russia are about 15-20 % of the market price at which Russia's gas is sold to Germany *(EIA, 2008).* These low domestic prices for petroleum products are achieved by high export taxes for oil as well as a government determined domestic price for gas and electricity *(ERIRAS, 2009).*

The main goal of the Russian Energy Strategy up to 2030 is to increase the energy efficiency and ensure the stable development of the energy supply. Among other policy reforms, the Russian government wants to liberalize energy markets in the long run. Increasing energy prices should lead to more efficient energy use *(MERF, 2009).*

This analysis is based on version 7 of the GTAP database, which describes the economic state of Russia in 2004. According to the database, the final consumption of energy commodities is taxed in Russia, but almost all sectors receive a tax rebate of about 37 % for the use of coal and about 20 % for the use of petroleum, it means they pay a low tax rate relative to households (Table 2 and Annex Table A2). The tax rebates for coal and petroleum are almost

the same for all sectors except for services and electricity production. The service sector receives a tax rebate of 3 % for the use of coal. The electricity production sector pays a higher tax rate of 9 % for the use of petroleum products relatively to households.

Table 2: Sale Tax and Input Tax/Tax Rebate for the Use of Energy Commodities by Activity (%)

	Sale tax	Unweighted average input tax (+) and tax rebate (-)
Coal	67	-37
Oil	no	no
Gas	01	19
Petroleum coal products	33	-20
Electricity	05	15
Gas manufacture	01	01

Source: own calculation based on the SAM 2007 for Russia

3. Model Framework and Simulations

Energy prices affect markets through many channels: directly through changes in production costs and indirectly through macroeconomic effects *(Francois and Gohin, 2009).* The energy sectors play a very important role for the Russian economy and hence the macroeconomic effects could be very important. Therefore, we use a single country CGE model "SMOD" *(McDonald, 2010)* based on version 7 of the GTAP database. For the economy-wide analysis, we aggregate the data into 16 sectors and 16 commodities.

The behavioral parameters, such as the Armington elasticities and substitution elasticities for the production nesting, are also taken from version 7 of the GTAP database. In addition, in the "SMOD" model we depict the export supply through a constant elasticity of transformation function (CET) which is not used in the GTAP model. Using a CET formulation allows the use of smaller Armington elasticities for the same terms of trade effects; therefore all the GTAP Armington elasticities are halved. We do not have the estimated elasticities of transformation for the CET function, because there is scarce empirical data on CET elasticities. For simplicity we divide all commodities into three groups according to the degree of homogeneity. We assume all fossil energy commodities and water to be quite homogeneous and set the elasticities of transformation to (3.00). For less homogeneous commodities, such as agriculture, minerals, textiles and trade, we decrease the CET elasticities to (1.50). All other commodities, such as food products, heavy and light

manufacturing, construction and services, are quite heterogeneous and hence we set the elasticities of transformation to (0.75) (Annex Table A3).

3.1 Main Features of the SMOD Model

According to Burniaux and Truong (2002: P. 27), "The issue of energy substitution between capital and energy goods is a key factor and may turn out to be a crucial one in determining the direction of the adjustment of aggregate output following energy price changes". The whole Russian economy has a large potential to improve energy efficiency through technological progress because most of its technology is outdated and could be replaced by new, less energy intensive technology. From this, we derive our methodological objective: to analyze the relevance of substitution possibilities between energy and capital as well as to investigate the impact of energy price changes on sectoral and economy-wide output through a nesting structure of energy commodities in a CGE model. Therefore, we extend the standard version of the CGE model "SMOD" by incorporating substitution possibilities between capital and energy goods. The capital-energy composite is modelled through a CES production function with a uniform elasticity of substitution (2.00).

As the econometric evidence is scarce, the discussion about the distinction and substitution possibilities among energy goods within the energy composite is rather theoretical and based on plausibility considerations *(Burniaux and Truong, 2002)*. The substitution possibility among energy goods is different from sector to sector: however, we do not have enough information about these substitution possibilities to suggest a nesting structure of the energy composite that would be more appropriate for the Russian economy. Therefore, we assume two extreme cases with respect to the nesting structure of all sectors.

First, the standard CES nesting structure depicts a substitution possibility among all energy goods with a uniform elasticity of substitution (2.00). The energy composite is depicted by a CES production function (Figure 3). Energy commodities are used for different purposes, such as heating, lighting, fuel etc., but they could be replaced by each other. For example, we can use different energy commodities for heating. So the CES nesting structure of the energy composite in the model depicts some technological flexibility in the use of different energy inputs. The nesting structure of the energy composite for the electricity production sector describes different technologies for electricity generation: coal-fired, gas-fired, oil-fired etc. The main input for electricity generation in Russia is natural gas with a share of 40 %, followed by nuclear (24 %), coal (20 %) and hydro (15 %) *(APEC, 2006)*. Nevertheless, a

problem with such functional forms as CES production function, as discussed in a technical paper for the MEGABARE model *(ABARE, 1996)*, is that they may allow for the possibility of choosing input combinations inconsistent with known technologies. This issue could be relevant for the depiction of the electricity production sector and other energy intensive sectors in Russia because of the importance of energy sectors for the Russian economy as well as the interrelationships between energy sectors.

Second, in the Leontief nesting structure all energy goods are complements within the energy composite. The energy composite is depicted through a Leontief production function (Figure 4). We use this nesting structure for the sensitivity analysis to compare results to those under the standard CES nesting structure.

Figure 3: Structure of the Production Nesting for SMOD Model

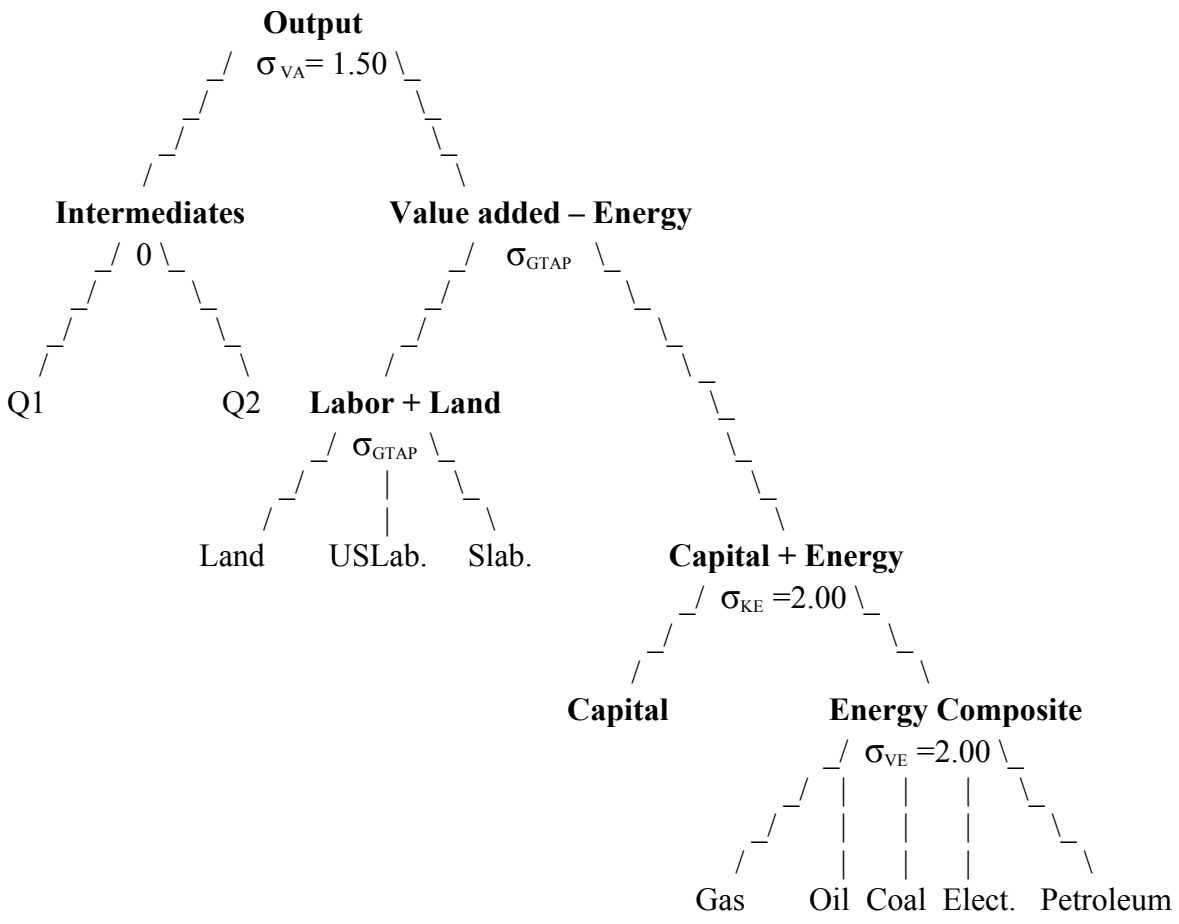


Figure 4: Structure of the Energy Composite for Leontief Nesting

```
                Energy Composite
                   _/     0     \_
                 _/  |    |    |  \_
               _/    |    |    |    \_
             /       |    |    |      \
Gas        Oil  Coal  Elect.  Petroleum
```

3.2 Model Closure

In the model we assume the following closure rules:

- *Foreign Exchange Closure:* the external trade balance is fixed and the exchange rate is flexible so that changes in the exchange rate clear the foreign exchange market.
- *Investment-Savings Closure:* volumes of investment are fixed and household savings rates are variable so that the capital accounts are cleared by changes in the household savings rate.
- *Government Account Closure*: government savings rates and government consumption are fixed and income tax is variable so that the change in the income tax compensates for the loss in revenues from the tax rebate removal and clears the government accounts.
- *Factor Market Closure:* there is full employment of skilled and unskilled labor and full capital mobility. We assume immobility of natural resources; land is used only by the agricultural sector und hence it is a *de facto* immobile resource.

3.3 Simulations

Based on the version 7 of the GTAP database we consider three scenarios that we carry out using the CES nesting structure for the energy composite. The scenarios are summarized as follows:

Scenario	**Description**
Removal of the tax rebates for coal	Elimination of the tax rebates for the use of coal for all sectors (the average unweighted tax rebate rate is 37 %).
Removal of the tax rebates for petroleum	Elimination of the tax rebates for the use of petroleum for all sectors (the average unweighted tax rebate rate is 20 %).
Removal of the tax rebates for coal and petroleum	Elimination of the tax rebates for the use of both coal and petroleum for all sectors.

The elimination of these tax rebates implicates an increase in prices for the use of coal and petroleum by sectors. The most interesting and policy relevant experiment would be to

increase domestic prices for gas and electricity. As previously mentioned, domestic prices for gas and electricity are administratively regulated and are significantly below export prices. Furthermore, the Russian government aims to increase domestic prices for gas and electricity in the long run *(EIA, 2008).* However, running this experiment requires additional work on the standard GTAP database.

4. Analysis of Results

4.1 Macroeconomic Effects

As a consequence of the tax rebate elimination, input costs for the use of coal and petroleum as an input for other sectors increase. Therefore, most of the sectors become less competitive and hence we observe a relatively small production decline in almost all sectors. The demand for primary factors decreases and hence prices of primary factors decrease (Table 3). On the one hand, a decrease in prices of primary factors results in a reduction of production costs per unit; on the other hand, a decrease in prices of primary factors decreases household income. For example, by removing the tax rebate for the use of petroleum, the total household expenditure decreases relatively stronger than it is by removing the tax rebates for coal because of a stronger decrease in prices of primary factors.

Table 3: Macroeconomic and Aggregate Effects of the three Simulations, (change in %)

	Removal of tax rebates for coal	Removal of tax rebates for petroleum	Removal of tax rebates for coal and petroleum
GDP	-0.26	-0.25	-0.52
Exchange rate	-0.08	0.06	-0.02
Factor prices:			
- Capital	-0.28	-0.54	-0.82
- Land	-0.82	-2.56	-3.40
- Natural resources	-2.60	-6.21	-8.66
- Skilled labor	-0.43	-0.74	-1.16
- Unskilled labor	-0.54	-0.88	-1.41
Household expenditure	-0.37	-0.49	-0.87

Source: model simulation results

The real exchange rate appreciates slightly with the removal of tax rebates for coal, whereas in case of the removal of tax rebates for petroleum we observe a depreciation of the currency. Finally, the removal of the tax rebates for the use of coal and petroleum has a small adverse effect on the Russian economy, resulting in a decrease of the GDP by 0.52 %, because of the decrease in production in almost all sectors.

4.2 Approach

The removal of the tax rebates for the use of coal and petroleum products impacts supply as well as demand according to the nature of the model. The analysis of results is quite complex because we have different effects on both sides and all changes occur simultaneously. For this analysis we distinguish the following effects:

Effects	**Description**
Supply	
- first round effect	increase in energy prices → increase of energy costs in production
- second round effect	decrease in factor prices → decrease of factor costs in production
- third round effect	depreciation of the currency → the production shifts relatively from domestic to export markets (vice versa if the currency appreciates)
- fourth round effect	change of purchase prices for composite commodities → change of costs for intermediates in production
Demand	
- first round effect	increase in energy prices → decrease of domestic demand for energy goods
- second round effect	decrease in prices for primary factors → decrease of factor income and hence decrease of household income
- third round effect	depreciation of the currency → the demand shifts relatively from import to domestic products (vice versa if the currency appreciates)
- fourth round effect	change of purchase prices for composite commodities → change of the demand for intermediate

The increase in prices for energy goods implicates an increase in energy costs. The first round effect induces the second round effect through a change in the demand for primary factors. The demand for primary factors decreases and hence prices for primary factors decrease as well. In the model, the activity prices indicate the production cost per unit. For this analysis we consider only the activity price for the energy-factor aggregate (PVAE) and the activity price for intermediates (PINT) because the signs of these activity prices indicate the final production cost effect.

Domestic demand consists of household, intermediate, government and investment demand. Households suffer from the second round effect because of the decrease in prices of primary factors, which results in a decrease in household income. In addition, increasing saving rates and income tax rates negatively influences household income. According to the model closure rules, the capital account is cleared by changes in household saving rates, which compensate

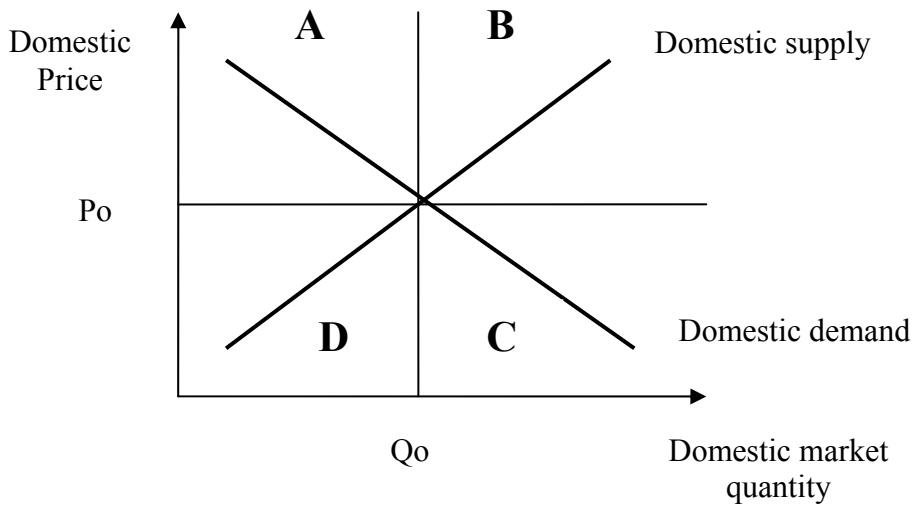
losses in revenues from the removal of tax rebates. Government expenditure, government saving and investment demand are constant. Thus, we consider changes in household and demand for intermediates only.

The total change in production also affects the trade balance. This creates a third round effect through a change in the exchange rate which results in a change in the ratio between domestic, import and export prices. A depreciation of the currency is an incentive to increase the consumption of domestic commodities and to shift the production from domestic to export markets, and vice versa if the currency appreciates. Nevertheless, the final effect depends on which of the two, the income or the substitution effect, is dominant. In the model, this mainly depends on trade elasticities and trade shares.

The change in purchase prices for composite commodities constitutes the fourth round effect. The demand for intermediates changes because of a change in costs for intermediates. According to the CES production structure, a substitution possibility exists between intermediates and the energy-factors composite. Therefore, any changes in activity prices for intermediates directly impact intermediate as well as factor demand and vice versa.

The final market outcome depends on how strong these effects are relatively to each other. We can compare relative impacts of these effects to understand what drives supply and demand as well as the final market outcome. The starting point of the interpretation of results for each sector is the location of the new equilibrium state of domestic demand and supply (Figure 5). Domestic supply is domestic production without production for exports, while domestic demand is total domestic demand without demand for import commodities. Graphically we would observe shifts in the demand and supply curves for domestic commodities. The location of the new equilibrium quantity and equilibrium prices is defined by an interaction between demand and supply.

Figure 5



According to the results, the following options are possible:

- If the new equilibrium lies in quadrant "A", the domestic equilibrium quantity decreases and the equilibrium price for domestic commodities increases. This is because the negative effect on the supply side is relatively stronger than any effects on the demand side. These activities should be either quite energy intensive and suffer a relatively strong first round effect or suffer a negative fourth round effect, if the cost of intermediates increases strongly. Graphically, we see that the supply curve for domestic commodities shifts to the left. In addition, we have to take into account that the decrease in domestic supply would be enforced by the third round effect if the currency depreciates and vice versa if the currency appreciates.

- If the new equilibrium lies in quadrant "C", the domestic equilibrium quantity increases and the equilibrium price for domestic commodities decreases. This is because the positive effect on the supply side is relatively stronger than any effects on the demand side. The production costs for these activities decrease because of decreasing price for primary factors or decreasing intermediates cost. Graphically, the supply curve for domestic commodities would shift to the right. On the other hand, the increase in domestic supply would be diminished if the currency depreciates, implicating a shift of production from domestic to export markets. The direction of the change in the demand curve for domestic commodities for the cases "A" and "C" is not clear. On the one hand, household demand tends to decrease because of the decrease in household income. The change in intermediate demand is different from

sector to sector. In addition, the third round effect establishes an incentive for the consumer to buy more domestic commodities.

- If the new equilibrium lies in quadrant "D", the domestic equilibrium quantity and equilibrium price for domestic commodities decreases. The negative effect on the demand side is relatively stronger than any effects on the supply side. The second round effect should have a large negative impact on household income or the intermediate demand. Graphically, we see that the demand curve for domestic commodities shifts to the left. On the other hand, the decline in domestic demand would be diminished by the third round effect if the currency were to depreciate. Import commodities become more expensive and hence buyers shift to domestic commodities.

- If the new equilibrium lies in quadrant "B", the domestic equilibrium quantity and equilibrium price for domestic commodities increase. The positive effect on the demand side is relatively stronger than any effects on the supply side. Graphically, we see that the demand curve for domestic commodities shifts to the right. This may be caused by an increase in household or government income or an increase in demand for intermediates. In addition, demand as well as supply would be influenced by the third round effect through changes in the ratio between domestic and import prices. The direction of the change of supply curve for domestic commodities for the cases "B" and "D" depends on two opposite effects: the change in production cost and the change in the ratio between domestic and export prices.

Based on this schedule, we can analyze the relative impacts of these effects on supply and demand and thus the final market outcome.

4.3 Removal of the Tax Rebates for the Use of Coal

Table 4 shows percentage changes in domestic production. As previously mentioned domestic production consists of domestic and export supply. As a result of the elimination of the tax rebates for the use of coal, production decreases slightly in almost all sectors.

Table 4: Domestic Production from the Removal of Tax Rebates for the Use of Coal and/or Petroleum by Activity, (change in %)

	Removal of tax rebates for coal	Removal of tax rebates for petroleum	Removal of tax rebates for coal and petroleum
Agriculture	-0.22	-0.80	-1.02
Coal	-19.52	-2.37	-20.62
Oil	-0.03	-3.37	-3.38
Gas	0.20	-1.99	-1.79
Minerals	-0.73	-1.98	-2.70
Food products	-0.23	-0.61	-0.86
Textiles	-0.43	-0.16	-0.61
Petroleum coal products	-1.96	-21.54	-23.00
Heavy manufacturing	-1.26	-2.78	-4.00
Light manufacturing	-0.58	-0.79	-1.36
Electricity	-3.32	2.59	-0.81
Gas manufacture	0.17	-0.56	-0.41
Water	-0.51	-0.97	-1.48
Construction	-0.10	-0.47	-0.56
Trade	-0.48	-2.21	-2.67
Services	-0.20	-0.76	-0.94

Source: model simulation results

By removing the tax rebate for coal, the use of coal products by sectors becomes more expensive. As a result, the production of coal decreases by 19.52 % because of a strong decrease in domestic demand for coal. Furthermore, the export supply of coal increases by 10.85 %. Production, in particular, production declines for the main domestic consumer of coal, the electricity sector.

We observe a small increase in the production of gas (0.20 %) and gas manufacture (0.17 %). These sectors face a relatively strong positive effect on the supply side, namely a decrease in production costs per unit, which establishes an incentive to extend the production. This is indicated by an increase in domestic equilibrium quantity and a decrease in the domestic equilibrium price for gas and gas manufacture. Table A4 in the annex shows the percentage changes in activity price for the energy-factor aggregate (PVAE) and the activity price for intermediates (PINT). A decrease in the PVAE as well as the PINT results in a decrease in production costs per unit. The increase in production of gas and gas manufacture is also affected by the substitution possibility among energy commodities.

The production costs per unit decrease in sectors such as agriculture, coal, minerals, food products, textiles, trade, light manufacturing, construction and services. This is indicated by a

decrease in activity prices for PVAE and PINT for almost all activities (Annex Table A4). The PVAE falls for all of these activities because the decrease in prices for primary factors outweighs the increase in energy prices; however, the negative effect on the demand side is relatively stronger. Thus, the domestic equilibrium quantity and price decrease. The negative demand effect is created by a decrease in household income as well as intermediate demand. Therefore, the production falls slightly in these sectors. The export supply of agricultural and oil increases by 0.15 % and 0.30 %, respectively, because the substitution effect between export and domestic supply outweighs the negative output effect.

The sectors that are most adversely affected by the removal of tax rebates for coal are electricity, petroleum, heavy manufacturing and water. These activities are subject to a strong increase in production costs, which is indicated by a decrease in the domestic equilibrium quantity and an increase in the domestic equilibrium price. We observe an increase in the PVAE in these sectors (Annex Table A4). The electricity and petroleum production sectors are the largest consumers of coal. The electricity production sector has a share of 67 % and the petroleum production sector has a share of 24 % in the total domestic consumption of coal (Annex Table A1). Therefore, the cost share of coal consumption is quite large in the electricity and petroleum sectors (Annex Table A5). Due to the increase in production costs in the electricity and petroleum sectors, the production falls and thus domestic prices for electricity and petroleum increase. Consequently, the heavy manufacturing sector is adversely affected by the increase in the price of electricity because heavy manufacturing is very electricity intensive. The heavy manufacturing sector is the largest domestic consumer of electricity among other sectors. Its share in total domestic electricity consumption is about 30 %. Consequently, the domestic production as well as export supply of petroleum, electricity, heavy manufacturing and water sectors decrease.

4.4 Removal of the Tax Rebates for the Use of Petroleum

In case of an elimination the tax rebates for petroleum, the use of petroleum becomes more expensive. As a result, the production of petroleum decreases by 21.54 % because of a strong decrease in domestic demand for petroleum (Table 4). As a consequence of the strong negative output effect, the export supply of petroleum decreases by 17.28 %.

Production of electricity increases by 2.59 % mainly because of a relatively strong positive effect on the supply side. This is indicated by an increase in the domestic equilibrium quantity and a decrease in the domestic equilibrium price. The prices for primary factors as well as

prices for coal and gas decrease, implying a decrease in production costs per unit. For the electricity production sector we eliminate an input tax for the use of petroleum of 9 %. As previously mentioned, the electricity production sector pays a more tax rate for the use of petroleum relatively to households, whereas all other sectors receive a tax rebate of about 20 %. As a result of the production increase, exports of electricity increase by 10.52 %.

The sectors, which are most adversely affected by the removal of the tax rebates, are heavy manufacturing, trade and construction. These sectors suffer a strong increase in production costs. The domestic equilibrium quantity decreases and the domestic equilibrium price increases for these commodities. Heavy manufacturing and trade are quite petroleum intensive sectors. The trade sector is the largest domestic consumer of petroleum products (28 % of total domestic consumption). The consumption share of petroleum in the heavy manufacturing sector is also relatively large (13 % of the total domestic consumption). In turn, the construction sector is very depending on the heavy manufacturing intermediates (Annex Table A1). Finally, exports of these commodities decrease because the negative output effect outweighs the substitution effect between export and domestic supply, which is caused by a depreciation of the currency.

The production for all other sectors mainly decreases because of the relatively strong impact on the demand side. We observe a decrease in domestic equilibrium quantity and domestic equilibrium prices. This negative effect is explained by a decrease in household income and a decrease in intermediate demand. These sectors face a decrease in costs for primary factors (the PVAE falls), but the activity prices for intermediates increase for all sectors. Therefore, the gross effect on the supply side depends on the relative change in activity prices and the primary factor intensity.

4.5 Removal of the Tax Rebates for the Use of Coal and Petroleum

The removal of the tax rebates for the use of coal and petroleum results in a decrease in coal production by 20.62 % and in petroleum production by 23.00 % because of a strong decrease in domestic demand for these energy commodities. Furthermore, the export supply of coal increases by 11.51 %, whereas the export supply of petroleum products declines by 20.10 % because of a strong negative output effect.

Production in all sectors declines after the removal of tax rebates for coal and petroleum. The heavy manufacturing and trade sectors are negatively impacted the most from the strong increase in production costs. We observe a decrease in the domestic equilibrium quantity and

an increase in domestic equilibrium prices. The activity prices for the energy-factor composite and for intermediates increase, implying an increase in production costs per unit. For all other sectors, we observe a relatively strong negative effect on the demand side, which is indicated by the decrease in the domestic equilibrium quantity and price. Furthermore, we observe an increase in the export supply by sectors such as coal (11.51 %), oil (5.57 %), electricity (1.15 %) and gas manufacture (0.93 %).

5. Sensitivity Analysis

We divide the sensitivity analysis into two parts. In the first part we carry out the same experiments with different nesting structures for the energy composite. We assume two extreme cases, namely a Leontief and a CES nesting structure for the energy composite for all activities. Within the Leontief nesting structure, all energy goods are complements and thus the energy composite is depicted through a Leontief production function. The CES nesting structure, on the other hand, depicts a substitution possibility among energy goods with the same elasticity of substitution for all energy goods (2.00). We carry out two experiments, namely the removal of the tax rebates for the use of coal and petroleum. For the sensitivity analysis we assume the initial model closure rules.

In the second part, we compare the effects of the removal of the tax rebates for coal using different elasticities of substitution between the capital and energy composite. We use the CES nesting structure for the energy composite and the initial model closure rules. We increase the elasticity of substitution between the capital and energy composite from 2.00 to 6.00 for all sectors.

5.1 Removal of the Tax Rebates for Coal using CES and Leontief Nesting Structure

Under the Leontief nesting structure, in comparison to the CES nesting structure, we observe a stronger decrease in the GDP (Table 5). This is because the whole economy under the Leontief nesting structure is less flexible and hence becomes less competitive in the case of the removal of the tax rebates for coal. The exchange rate appreciates more under the Leontief nesting structure, because under the Leontief nesting structure we observe a strong negative effect on the demand side with respect to oil and gas products so that production of oil and gas shifts much more from domestic to export markets, implying a stronger currency appreciation than under the CES nesting structure. In comparison to the CES nesting

structure, under the Leontief nesting structure the demand for capital and labor decreases stronger, this implicates a stronger decrease in prices for factors.

Table 5: Macroeconomic and Aggregate Effects of the Removal of the Tax Rebates for Coal, (change in %)

	CES nesting	Leontief nesting
GDP	-0.26	-0.29
Exchange rate	-0.08	-0.19
Factor prices:		
- Capital	-0.28	-0.52
- Land	-0.82	-0.52
- Natural resources	-2.60	-2.50
- Skilled labor	-0.43	-0.64
- Unskilled labor	-0.54	-0.71
Household expenditure	-0.37	-0.31

Source: model simulation results

Table 6 shows the percentage change in domestic production in case of the removal of tax rebates for coal using the CES and Leontief nesting structures. The nesting structure of the energy composite has a strong effect on the production of all energy sectors. Therefore, we discuss the effects in detail for energy production sectors only.

Table 6: Domestic Production from the Removal of Tax Rebates for Coal using CES and Leontief Nesting Structures, (change in %)

	CES nesting	Leontief nesting
Agriculture	-0.22	-0.11
Construction	-0.10	-0.17
Coal	-19.52	-2.44
Electricity	-3.32	-3.81
Food products	-0.23	-0.16
Gas	0.20	-3.49
Gas manufacture	0.17	-3.22
Heavy manufacturing	-1.26	-1.44
Light manufacturing	-0.58	-0.58
Minerals	-0.73	-0.73
Oil	-0.03	-0.72
Petroleum coal products	-1.96	-3.19
Services	-0.20	-0.22
Textiles	-0.43	-0.43
Trade	-0.48	-0.64
Water	-0.51	-0.49

Source: model simulation results

According to our approach, we consider the relative changes in domestic equilibrium quantity and domestic equilibrium price for the two nesting structures (Table 7). Under the CES and Leontief nesting structures we observe a decrease in the domestic equilibrium quantity and domestic equilibrium price for coal production. This results in a relatively strong negative effect on the demand side; however, under the Leontief nesting structure the decrease in production is much smaller (2.44 %) than under the CES nesting strucutre (19.52 %). This is because under the CES nesting structure, all sectors can switch from coal to other energy commodities. Therefore, the decrease in intermediate demand for coal is enforced by the substitution possibility, which is allowed under the CES nesting structure.

Table 7: Domestic Equilibrium Quantity (QD) and Domestic Equilibrium Price (PD) from the Removal of Tax Rebates for Coal Using CES and Leontief Nesting Structures, (change in %)

	QD		PD	
	CES nesting	Leontief nesting	CES nesting	Leontief nesting
Coal	-40.88	-4.41	-18.97	-1.89
Electricity	-3.27	-3.74	1.78	2.99
Gas	0.20	-4.38	-0.07	-2.15
Gas manufacture	0.14	-3.23	-0.14	-0.19
Oil	-0.41	-3.25	-0.31	-1.79
Petroleum products	-1.56	-3.00	0.59	0.13

Source: model simulation results

The production of electricity decreases with the removal of the tax rebates for coal under both nesting structures. We observe a decrease in the domestic equilibrium quantity and an increase in the domestic equilibrium price. This implicates a relatively strong negative effect on the supply side because of an increase in production costs. Under the Leontief nesting structure, the decrease in the domestic equilibrium quantity and increase in the domestic equilibrium price is stronger than under the CES nesting structure. This is because the CES nesting structure allows switching of the energy use to other energy commodities and hence the increase in production costs is less under the CES than under the Leontief nesting structure. Consequently, a stronger increase in the price for electricity has a more adverse impact on production in the electricity intensive sectors such as heavy manufacturing.

As discussed above, when the tax rebates for coal are removed, the production of gas and gas manufacture increases under the CES nesting structure mainly because of a decrease in production costs. On the other hand, under the Leontief nesting structure the production of gas

and gas manufacture decreases because of a strong decrease in domestic demand for these energy goods, which is indicated by a decrease in the domestic equilibrium quantity and price. This is because under the Leontief nesting structure there is no substitution possibility among energy commodities. In addition, the decrease in domestic demand for gas and gas manufacture is enforced by a negative output effect because of increasing production costs. For example, the production of electricity decreases relatively stronger under the Leontief than the CES nesting structure because of a stronger increase in production costs. The decrease in production of electricity strongly influences domestic demand for gas and gas manufacture. As already mentioned, the electricity production sector is the largest domestic consumer of gas and gas manufacture.

For the same reasons, namely a decrease in domestic demand and a stronger negative output effect, the production of petroleum decreases relatively stronger under the Leontief nesting structure in comparison to the CES nesting structure. Consequently, the production of oil decreases further because the petroleum production sector is the largest domestic consumer of oil. However, because of a stronger decrease in domestic demand for gas and oil under the Leontief nesting structure, production shifts to export markets and hence exports of oil and gas increase more under the Leontief nesting structure in comparison to the CES nesting structure, implying a stronger currency appreciation.

5.2 Removal of the Tax Rebates for Petroleum using CES and Leontief Nesting Structures

Under the Leontief nesting we observe a significantly stronger decrease in GDP than under the CES nesting structure (Table 8). Again, this is because under the Leontief nesting structure, all production sectors are less flexible than under the CES nesting structure. In addition, the prices of all production factors decrease more under the Leontief nesting structure than under the CES nesting structure, implying a stronger decline in household income. We also observe an appreciation of the currency under the Leontief nesting structure, whereas under the CES nesting structure the currency depreciates.

Table 8: Macroeconomic and Aggregate Effects of the three Simulations, (change in %)

	CES nesting	Leontief nesting
GDP	-0.25	-0.51
Exchange rate	0.06	-0.07
Factor prices:		
- Capital	-0.54	-0.81
- Land	-2.56	-3.43
- Natural resources	-6.21	-8.34
- Skilled labor	-0.74	-1.27
- Unskilled labor	-0.88	-1.45
Household expenditure	-0.49	-0.83

Source: model simulation results

The results are quite different from sector to sector but we discuss in detail only the effects for the energy production sectors (Table 9).

Table 9: Domestic Production from the Removal of Tax Rebates for Petroleum using CES and Leontief Nesting Structures, (change in %)

	CES nesting	Leontief nesting
Agriculture	-0.80	-1.03
Construction	-0.47	-0.61
Coal	-2.37	-2.71
Electricity	2.59	-4.63
Food products	-0.61	-0.84
Gas	-1.99	-5.07
Gas manufacture	-0.56	-4.42
Heavy manufacturing	-2.78	-3.80
Light manufacturing	-0.79	-1.08
Minerals	-1.98	-2.63
Oil	-3.37	-3.17
Petroleum coal products	-21.54	-12.66
Services	-0.76	-0.95
Textiles	-0.16	-0.29
Trade	-2.21	-2.97
Water	-0.97	-1.34

Source: model simulation results

The production of petroleum products decreases under the CES nesting structure mainly because of a relatively strong negative effect on the demand side, which is indicated by a decrease in the domestic equilibrium quantity and domestic equilibrium price (Table 10). Under the Leontief nesting structure, there is no substitution possibility among energy commodities. Therefore, the decrease in intermediate demand for petroleum is smaller under

the Leontief nesting structure than under the CES nesting structure: however, under the Leontief nesting structure the production costs per unit increases, implying a decrease in the domestic equilibrium quantity and an increase in the domestic equilibrium price. Consequently, the production of oil decreases less under the Leontief nesting structure than under the CES nesting structure because the petroleum production sector is the largest domestic consumer of oil.

Table 10: Domestic Equilibrium Quantity (QD) and Domestic Equilibrium Price (PD) from the Removing of Tax Rebates for Petroleum using CES and Leontief Nesting Structures, (change in %)

	QD		PD	
	CES nesting	Leontief nesting	CES nesting	Leontief nesting
Coal	-4.51	-5.13	-1.79	-2.15
Electricity	2.52	-4.70	-2.42	-2.57
Gas	-2.17	-5.92	-0.33	-1.97
Gas manufacture	-0.87	-4.82	-0.46	-0.75
Oil	-13.31	-12.43	-6.23	-5.92
Petroleum products	-22.67	-12.56	-2.16	0.11

Source: model simulation results

As discussed above, when the tax rebate for petroleum is removed, the production of electricity increases under the CES nesting structure because of decreasing production costs; however, under the Leontief nesting structure, the production of electricity decreases because of a strong decrease in the demand for electricity. This is indicated by a decrease in the domestic equilibrium quantity and the domestic equilibrium price under the Leontief nesting structure.

Consequently, the decrease in the production of electricity has a strong influence on the domestic demand for energy commodities such as coal, gas and gas manufacture, which are the largest energy inputs in electricity generation. We observe a stronger decrease in domestic equilibrium quantity and price under the Leontief nesting structure compared to the CES nesting structure, which implicates a stronger decline in the domestic demand.

5.3 Removal of the Tax Rebates for Coal using Different Substitution Elasticities

In this section, we remove the tax rebates for the use of coal by using the CES nesting structure with different elasticities of substitution between capital and energy commodities.

We increase the elasticities of substitution between capital and the energy composite to 6.00 and compare results to those from the standard formulation with CES elasticities at 2.00.

Under high elasticities of substitution between capital and energy, we observe an increase in the price for capital but prices for other production factors decrease relatively stronger than under the initial elasticities. This implicates a stronger decrease in household income. Finally, the GDP decreases more under high elasticities than under the initial elasticities. Table 12 shows the change in domestic production with different elasticities of substitution (Table 12).

Table 11: Macroeconomic and Aggregate Effects of the three Simulations, (change in %)

	σ_{KE} 2.00	σ_{KE} 6.00
GDP	-0.26	-0.33
Exchange rate	-0.08	-0.10
Factor prices:		
- Capital	-0.28	0.04
- Land	-0.82	-1.08
- Natural resources	-2.60	-3.76
- Skilled labor	-0.43	-0.57
- Unskilled labor	-0.54	-0.71
Household expenditure	-0.37	-0.50

Source: model simulation results

Table 12: Domestic Production from the Removal of Tax Rebates for Coal using the CES Nesting Structure with Different Elasticities of Substitution, (change in %)

	σ_{KE} 2.00	σ_{KE} 6.00
Agriculture	-0.22	-0.31
Construction	-0.10	-0.18
Coal	-19.52	-19.83
Electricity	-3.32	-4.30
Food products	-0.23	-0.39
Gas	0.20	-0.82
Gas manufacture	0.17	-1.27
Heavy manufacturing	-1.26	-1.43
Light manufacturing	-0.58	-0.70
Minerals	-0.73	-0.99
Oil	-0.03	-0.33
Petroleum coal products	-1.96	-2.68
Services	-0.20	-0.32
Textiles	-0.43	-0.57
Trade	-0.48	-0.86
Water	-0.51	-0.66

* σ_{KE} - elasticity of substitution between capital and energy composite

Source: model simulation results

On the one hand, production sectors are more flexible with higher elasticities and hence the increase in production costs should be less. On the other hand, an increase in elasticities of substitution between capital and the energy composite results in an increase in demand for capital and hence a decrease in demand for energy commodities. Consequently, the rent for capital increases which implies an increase in capital income for households and an increase in costs for the use of capital by activities. In addition, we have to take into account that higher elasticities on the upper nesting level have an impact on the lower nesting level. With substitution elasticities equal to 6.00, all energy commodities within the energy composite could be complements because of a negative output effect, which could be stronger than the substitution effect among energy commodities.

Production in almost in all sectors decreases relatively stronger with high elasticities of substitution. The differences in results are particularly significant for energy production sectors (Table 13). As discussed above, the production of gas and gas manufacture increase under the CES nesting structure under the initial elasticities when the tax rebates for coal are removed; however, with high elasticities we observe a decrease in production of all energy commodities. This is because of a relatively strong negative effect on the demand side. With high elasticities, the domestic quantity and price decrease in comparison to the results using the initial elasticities.

Table 13: Domestic Equilibrium Quantity (QD) and Domestic Equilibrium Price (PD) from the Removal of Tax Rebates for Coal using CES Nesting Structure with Different Elasticities of Substitution, (change in %)

	QD		PD	
	σ_{KE} 2.00	σ_{KE} 6.00	σ_{KE} 2.00	σ_{KE} 6.00
Coal	-40.88	-41.54	-18.97	-19.31
Electricity	-3.27	-4.26	1.78	1.58
Gas	0.20	-0.99	-0.07	-0.46
Gas manufacture	0.14	-1.29	-0.14	-0.14
Oil	-0.41	-1.11	-0.31	-0.60
Petroleum products	-1.56	-2.44	0.59	0.30

Source: model simulation results

Conclusions

Russia is one of the largest energy exporters and producers in the world. Therefore, energy sectors play an important role in the Russian economy. At the same time, the whole Russian economy is very energy intensive and the energy efficiency is low. One of the reasons for Russia's low energy efficiency is the low domestic price level for energy commodities. In this paper we analyze the effects of increased prices for coal and petroleum products caused by a removal of tax rebates based on a single country comparative static CGE model, "SMOD".

The results show that the removal of the tax rebates on the use of coal by sectors has a small negative impact on the Russian economy, decreasing the GDP by 0.26 %. As a result, the production of coal declines by 19.52 %. The sectors most adversely affected by the removal of tax rebates for coal are electricity, petroleum, heavy manufacturing and water production; however, the production of gas and gas manufacture increases slightly by 0.20 % and 0.17 %, respectively.

The removal of tax rebates for petroleum also has a negative effect on the Russian economy, decreasing the GDP by 0.25 %. The production of petroleum decreases by 21.54 %. The sectors most adversely affected by the removal of tax rebates for petroleum are heavy manufacturing, trade and construction; however, the production of electricity increases by 2.59 %.

The simultaneous removal of tax rebates for both coal and petroleum has the most adverse effect on the Russian economy, decreasing GDP by 0.52 %. As a result, we observe a decline in the domestic production of coal and petroleum by 20.62 % and 23.00 %, respectively, and a slight decrease in production of all other sectors.

Based on the sensitivity analysis, we can make two conclusions about "technical" and "sectoral" effects using different nesting structures of the energy composite. From the "technical" view point, the nesting structure has a direct impact on the change in production costs. Functional forms, such as the CES function, which allow for substitution within the energy composite are more flexible and hence allow adjustment to changes in production costs. Therefore, due to some substitution possibility, an increase in costs of energy use under the CES nesting structure will not be as strong as under a Leontief nesting structure.

Indirectly, the nesting structure influences each energy production sector through a change in demand for energy commodities. In comparison to the CES nesting structure, under the

Leontief nesting structure we observe a smaller decrease in domestic for energy commodities which become more expensive, and a stronger decrease in domestic demand for other substitute energy commodities because of the missing substitutability among energy commodities as well as a relatively stronger negative output effect. In other words, more flexible production functions with the possibility of substitution among energy commodities diminish the increase in energy costs on the supply side and enforce the increase in the domestic demand for other energy commodities.

Applying high elasticities of substitution between capital and the energy composite has different effects. Higher elasticities of substitution make the production technology more flexible and hence the increase in production costs should be smaller. Furthermore, according to the nature of the model we have general equilibrium effects. For example, high elasticities of substitution between capital and energy commodities induce an increase in demand for capital and hence the capital rent rises. This results in an increase in the costs for the use of capital and an increase in household income. In addition, it induces a decrease in demand for all energy commodities. With high elasticities of substitution between capital and the energy composite, energy commodities are characterized by a complementary relationship because of a stronger negative output effect in comparison to the substitution effect among energy commodities.

With respect to sectoral effects, we can conclude that energy production sectors are strongly related: for example, the electricity generation sector is the largest domestic consumer of coal, gas and gas manufacture. The petroleum production sector is the largest domestic consumer of oil products and the second largest domestic consumer of coal products. Therefore, the technological flexibility in electricity generation would have a strong impact on the domestic demand for gas and coal products. It means the adequate depiction of the electricity production sector would be a very important issue with respect to any energy policy simulations.

Discussion and Comments

Model Closure Rules

The issue of model closure rules is a very important part of CGE modeling. In this research paper we did not carry out any sensitivity analysis in terms of model closure rules. However, different model closures have different effects on the final outcome: for example, the closure rules for capital and government would have a strong impact on the production of services and construction. The government is the largest consumer of the production of services, with a share of 51 % of the total consumption value. The share of investment demand for construction commodities is about 71 % of the total investment value, whereas for the light manufacturing sector it is 25 %. Thus, any changes in government revenues and investment would have a strong demand effect on the production of services and construction.

We also assumed a free exchange rate, full employment and factor mobility except for natural resources. The unemployment rate in Russia in 2008 was about 7 % and hence the assumption of full employment seems justified. On the other hand, the assumption of capital mobility among sectors may be unrealistic, particularly in the short run. We assume capital mobility because otherwise the assumption of substitution possibility between capital and energy commodities breaks down.

External Terms of Trade Effects

For the energy policy simulations we used a single country CGE model; however, Russia is a large exporter of energy resources, particularly gas and oil products. We did not take into account any external terms of trade effects, which could be quite significant for the Russian economy. An increase in exports of oil or gas will decrease the world price for these energy commodities, resulting in an adverse external terms of trade effect for Russia and vice versa if exports of oil or gas decrease.

However, according to the results we do not observe very large changes in the export supply of oil and gas: the change is not greater than 2 % depending on the experiment. This means the terms of trade effect should not be very significant. For example, by removing the tax rebates for coal we observe an increase in the export supply of oil and gas by 0.23 % and 0.30 %, respectively. This would have an adverse impact on the Russian economy because the world price for gas and oil should fall. By removing the tax rebates for petroleum, the exports of gas decrease by 0.50 % but the exports of oil increase by 1.93 %.

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Annex

Table Description

cagric	Agriculture
ccoa	Coal
coil	Oil
cgas	Gas
cmin	Minerals
cfood	Food products
ctex	Textiles
cp_c	Petroleum coal products
chman	Heavy Manufacturing
clman	Light Manufacturing
cely	Electricity
cgdt	Gas manufacture distribution
cwtr	Water
ccns	Construction
ctrad	Trade
cserv	Services
aagric	Agriculture
acoa	Coal
aoil	Oil
agas	Gas
amin	Minerals
afood	Food Products
atex	Textiles
ap_c	Petroleum coal products
ahman	Heavy Manufacturing
alman	Light Manufacturing
aely	Electricity
agdt	Gas manufacture distribution
awtr	Water
acns	Construction
atrad	Trade
aserv	Services
fLnd	Land
fUSLab	Unskilled labor
fSLab	Skilled labor
fCap	Capital
govt	Government
hous	Private households
kap	Capital

Table A1: Shares of the Consumption Cost, %

	aagric	acns	acoa	aely	afood	agas	agdt	ahman	alman	amin	aoil	ap_c	aserv	atex	atrad	awtr	govt	hous	kap	Total
cagric	19	1	0	0	26	0	0	4	0	0	0	0	4	0	3	0	1	40	0	100
ccoa	0	0	0	67	0	0	0	2	0	0	0	24	1	0	0	0	0	5	0	100
coil	0	0	0	1	0	0	0	0	0	0	1	98	0	0	0	0	0	0	0	100
cgas	0	0	0	64	0	4	0	13	0	0	2	4	0	0	10	0	0	1	0	100
cmin	0	0	0	0	1	0	0	74	8	13	1	0	1	0	1	0	0	0	0	100
cfood	3	0	0	0	18	0	0	0	0	0	0	0	6	0	3	0	0	69	0	100
ctex	0	0	0	0	1	0	0	3	1	0	0	0	5	18	4	0	1	65	0	100
cp_c	3	1	0	15	1	0	0	13	0	0	0	17	6	0	28	0	0	15	0	100
chman	1	17	1	0	2	0	1	30	12	1	3	0	6	1	8	0	0	15	1	100
clman	2	4	1	0	1	0	1	3	15	0	2	0	8	0	10	0	0	19	33	100
cely	2	1	1	3	3	1	2	27	5	0	2	3	5	1	5	1	0	38	0	100
cgdt	0	0	0	42	0	0	0	8	1	0	1	1	2	0	9	0	0	36	0	100
cwtr	1	3	0	0	1	0	0	1	2	0	1	0	41	0	9	1	0	39	0	100
ccns	0	0	0	1	1	1	1	2	1	0	2	0	4	0	4	0	0	2	81	100
ctrad	2	5	1	2	3	5	1	7	3	0	6	0	7	0	13	0	1	43	2	100
cserv	0	1	0	1	1	1	0	2	2	0	3	0	10	0	7	0	51	19	2	100

Source: own calculation based on the SAM 2007 for Russia

Table A2: Sale Tax and Input Tax on the Use of Energy Commodities by Activities

	aagric	acoa	aoil	agas	amin	afood	atex	ap_c	ahman	alman	aely	agdt	awtr	acns	atrad	aserv	Unweighted Av. Rebate
ccoa	-0.38	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40	-0.39	-0.40	-0.39	-0.40	-0.32	-0.40	-0.40	-0.03	-0.37
coil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
cgas	0.63	-0.01	-0.01	-0.01	-0.01	0.04	-0.01	-0.01	0.52	0.72	0.49	-0.01	-0.01	-0.01	0.24	0.47	0.19
cp_c	-0.19	-0.25	-0.25	-0.25	-0.25	-0.19	-0.25	-0.25	-0.19	-0.19	0.09	-0.25	-0.19	-0.19	-0.19	-0.19	-0.20
cely	0.17	0.17	0.17	0.17	-0.05	0.17	0.17	0.17	0.17	0.17	-0.04	0.17	0.17	0.17	0.17	0.17	0.15
cgdt	0.01	-0.01	-0.01	-0.01	-0.01	0.01	0.01	-0.01	0.01	0.01	0.00	-0.01	0.03	0.00	0.02	0.12	0.01

Source: own calculation based on the SAM 2007 for Russia

Table A3: Elasticities for the SMOD Model

	Elasticities between primary factors	Elasticities for Armington CES function	Elasticities for Armington CET function
Agriculture	0.22	1.45	1.50
Coal	0.20	1.52	3.00
Oil	0.20	2.60	3.00
Gas	0.20	8.60	3.00
Minerals	0.20	0.45	1.50
Food products	1.12	1.48	0.75
Textiles	1.26	1.92	1.50
Petroleum products	1.26	1.05	3.00
Heavy manufacturing	1.26	1.68	0.75
Light manufacturing	1.26	1.93	0.75
Electricity	1.26	1.40	3.00
Gas manufacture	1.26	1.40	3.00
Water	1.26	1.40	3.00
Construction	1.40	0.95	0.75
Trade	1.60	0.95	1.50
Services	1.26	0.95	0.75

Table A4: Activity Price for Energy-Factor Aggregate (PVAE) and Activity Price for Intermediates (PINT), (change in %)

	PVAE			PINT		
	Remove TR* for coal	Remove TR for petroleum	Remove TR for coal and petroleum	Remove TR for coal	Remove TR for petroleum	Remove TR for coal and petroleum
Agriculture	-0.40	-0.32	-0.71	-0.20	0.17	-0.03
Coal	-18.01	-2.40	-19.20	-0.06	0.47	0.41
Oil	-0.22	-4.13	-4.30	-0.12	0.53	0.41
Gas	0.03	-1.46	-1.42	-0.16	0.74	0.58
Minerals	-0.66	-1.34	-1.97	-0.15	0.14	0.01
Food products	-0.05	-0.49	-0.52	-0.18	0.12	-0.05
Textiles	-0.08	-1.01	-1.08	-0.07	0.14	0.08
Petroleum products	0.47	-1.75	-1.29	-0.13	0.45	0.32
Heavy manufacturing	0.42	0.77	1.21	0.03	0.50	0.54
Light manufacturing	-0.13	-0.93	-1.04	0.02	0.34	0.36
Electricity	2.08	-2.87	-0.85	-0.15	0.58	0.43
Gas manufacture	-0.14	-0.90	-1.02	-0.10	0.55	0.45
Water	0.03	-0.69	-0.64	-0.06	0.50	0.45
Construction	-0.34	-0.54	-0.88	0.07	0.63	0.70
Trade	-0.19	1.11	0.92	-0.11	0.43	0.33
Services	-0.33	-0.30	-0.63	-0.13	0.22	0.10

**TR – tax rebate by sectors*
Source: model simulation results

Table A5: Shares of the Production Cost by Activities, %

	aagric	acns	acoa	aely	afood	agas	agdt	ahman	alman	amin	aoil	ap_c	aserv	atex	atrad	awtr
cagric	20	1	1	0	27	0	0	2	0	0	0	0	1	3	1	0
ccoa	0	0	1	11	0	0	0	0	0	0	0	3	0	0	0	0
coil	0	0	0	0	0	1	0	0	0	0	0	68	0	0	0	0
cgas	0	0	0	26	0	4	1	2	0	0	0	1	0	0	1	0
cmin	0	0	0	0	0	0	0	4	1	10	0	0	0	0	0	0
cfood	4	0	0	0	26	0	0	0	0	0	0	0	2	0	1	0
ctex	0	0	0	0	0	0	0	1	0	0	0	0	1	43	0	0
cp_c	4	1	0	20	1	0	0	7	0	0	0	17	2	0	8	2
chman	3	25	10	1	4	2	5	26	21	10	4	0	3	7	4	6
clman	3	6	10	1	2	1	5	2	24	5	3	0	5	1	4	6
cely	2	1	9	4	3	2	7	13	5	0	1	3	2	5	1	12
cgdt	0	0	0	9	0	0	0	1	0	0	0	0	0	0	0	0
cwtr	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
ccns	0	0	1	1	1	2	5	1	1	1	2	0	2	1	1	2
ctrad	8	14	18	10	11	44	20	12	10	10	16	1	8	10	13	14
cserv	1	2	6	3	2	6	3	3	5	8	7	1	10	2	6	2
fLnd	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
fUSLab	30	19	17	4	7	4	26	10	19	16	5	1	17	16	10	28
fSLab	1	3	1	2	1	1	11	2	4	2	1	0	23	2	2	12
fCap	8	28	4	9	14	14	15	13	7	29	36	5	21	8	46	13
fNatlRes	1	0	21	0	0	19	0	0	0	7	25	0	0	0	0	0
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: own calculation based on the SAM 2007 for Russia