

Heyndrickx, Christophe; Alexeeva-Talebi, Victoria; Tourdyeva, Natalia

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Implications of an increase in domestic prices of gas in Russia, an application of the regional economic model SUSTRUS

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1. Introduction

1.1 Dual pricing of natural gas

Beyond the horizon of the current political upheaval, one of the grand challenges which are faced by Russia is to ultimately liberalize its energy markets, in particular the gas market. Today, Russia has the largest gas reserves in the world and currently produces around 550 billion cubic meters of gas each year. Sixty percent of the production is sold domestically at prices below long term marginal cost, for households and for industrial producers. The pricing of natural gas is currently a hot topic in Russia, as the Russian government proposes to liberalize the regulated domestic market price and decrease subsidies for natural gas products. This is claimed to fit in a policy promoting energy efficiency, increasing investments in natural gas production and bringing the natural gas price on the domestic market closer to long term cost recovery. The elimination of “dual-pricing” has also been discussed in the context of Russian accession to WTO. In this paper we study economic and social impacts of an upward correction of the natural gas price in Russian regions, raising the question of its political feasibility and environmental effectiveness. This issue that has not yet attracted much attention in the literature but it is of immense importance for Russia’s development in the near- and mid-term perspective.

Underpricing of natural gas at the domestic markets was already an explicit feature of the Soviet era. Low gas prices were motivated from a political and economic perspective, stating that industrial growth could only be sufficiently maintained with cheap prices for natural resources and large state subsidies. In the post-Soviet period, domestic gas prices were kept at relatively low levels, though by 2006 this strategy had become increasingly untenable in the light of Gasprom’s investment needs into new extraction fields and a desire to “green-up” the economy. The target of reaching parity with the European export netback price by 2011 for domestic gas prices was set by Putin in November 2006. As a result, prices for gas have been rising gradually over the last five years, but they are not yet recovering long term marginal cost and do not reflect the current international market prices. In fact, the domestic gas prices remained in 2011 as far from netback parity as they have ever been in 2006, an outcome which is largely determined by sharp increase of oil prices to which long-term contract gas prices in Europe are linked (Henderson, 2011). The current legislature calls for a change of

strategy with respect of reaching parity and proposes to index the price of all energy sources to the level of inflation, but allow Gazprom to increase domestic gas prices at 10-15% each year (at double of the inflation rate), starting 2011.

Ongoing discussion on gas price liberalisation is closely related to the concern of the poor energy efficiency of the Russian economy. Over the last few years, the issue of energy efficiency improvement increasingly demanded attention. The Russian government started introducing a mix of structural policies to limit the energy consumption and to reduce GHG emissions while favouring longer-term growth of an economy and safeguarding competitiveness in the key industrial sectors. Despite some progress over the last two decades, the country is still among world's most intensive users of energy, while low energy intensity is endemic in every sector of economy. The heavy industry in particular has inherited an energy-inefficient and carbon-intensive production plants from the Soviet time, while the shortage of natural gas and electricity supplies to the industry become a factor determining "the limits of growth" in Russia in the 2000s (Bashmakov et al. 2008). The economic crisis 2007-2009 has even more disclosed the vulnerability of the "low-energy-efficiency" approach in the industrial landscape of both countries.

While the issue of raising gas prices has tangible implications for country's energy efficiency targets, the policy debate misses a comprehensive quantitative analysis of policy proposals. In the assessment of gas market reforms, the bulk of the research is skewed towards an export-driven perspective. Tsygankova M.A (2009) touches on the subject of dual pricing, claiming that equaling the price of gas on the European market and the domestic market, correcting for transportation costs and transfers would be necessary to avoid gas shortages in the future. Stern (2011) argues that Europe could find itself in competition for gas supplies with the Russian domestic and the CIS markets. There is a limited number of publications focusing on the domestic markets implications, most notably on social aspects. Estimating the long run marginal cost (LRMC) of gas production, Rutherford and Tarr (2003) concluded that the price on the Russian domestic market should be increased to full cost recovery, but not higher to avoid social inequality. Dudek et al. (2006) argue that dual pricing of natural gas remains the most efficient environmental policy for Russia as it prevents from an increase of coal combustion in existing facilities.

Neither of these studies investigated all relevant trade-offs pertaining gas price increases at the domestic market, including the social and environmental implications. Our paper provides

an impact assessment of gas price increases to illustrate potential pitfalls of alternative policy reforms. Based on quantitative simulations with a computable-general equilibrium model of Russia, SUSTRUS, we compare several scenarios of differential gas pricing strategies, simulating increases in price for industrial and private consumers at different annual growth rates, with a time horizon from 2012 until 2020. We find that deregulating natural gas pricing can lead to a significant improvement in energy efficiency, if prices are gradually increased for both consumers and industries alike. We show that increasing the consumer price of gas is indeed a regressive policy, but can be compensated for by the government. A policy of deregulation, by allowing Gazprom to act as a real monopoly on the domestic market is both negative for consumer welfare and social equality.

1.2 Energy efficiency in the Russian Federation and natural gas

Russia is the biggest consumer of natural gas in the world both in real and in relative terms. 56% of the domestic energy use can be directly attributed to natural gas. In the recent Worldbank and IEA report “Energy efficiency in Russia: untapped reserves”, claims are made on the possibilities to reduce energy intensity in Russia (source, year). This document takes a clear standpoint on the current ‘wasteful’ practices and offers a number of good arguments why Russia should care about energy efficiency. Russia has (among a comparative study of 121 countries) the 12th highest energy use by GDP¹ (measured in kilograms of oil equivalent). Russian energy use by GDP is equal to 0.42 kgoe² / dollar, which is much higher than other ‘cold’ countries in Europe like Iceland (+- 0.32 kgoe/dollar), Canada (0.25 kgoe/dollar), Sweden (0.18 kgoe/dollar). It is also more than double the amount of the United States (around 0.2 kgoe/dollar) and almost triple the amount of average EU countries (0.1-0.15 kgoe/dollar). This led the authors to claim that there is a huge unused potential for energy savings. In fact, by realizing its energy efficiency potential, Russia could save over 240 billion cubic meters of natural gas (almost two thirds of the current domestic consumption), 340 billion kWh of electricity, 89 million tons of coal and 43 million tons of crude oils.

Increasing energy efficiency would be beneficial for economic development on the long term, taking into account the dwindling resources of natural gas in Russia, as well as lead to an

¹ Corrected by Purchasing Power Parity (PPP)

² Kilograms of oil equivalent

important decrease in pollution (mainly carbon dioxide) associated with combustion. In Figure 1 the baseline of the SUSTRUS model for the autonomous improvement of energy intensity is given (horizon 2020) for each of the 7 regions. Not surprisingly, Siberia has by far, the largest energy intensity. This can be explained by the cold climate, the remoteness of the region and the abundance of natural resources in Siberia. The central region has the smallest energy intensity by GDP, but consumes (by far) the largest amount of energy of Russia. A positive evolution is expected for all regions, but even by 2020, it is projected the energy intensity will remain far above the EU level.

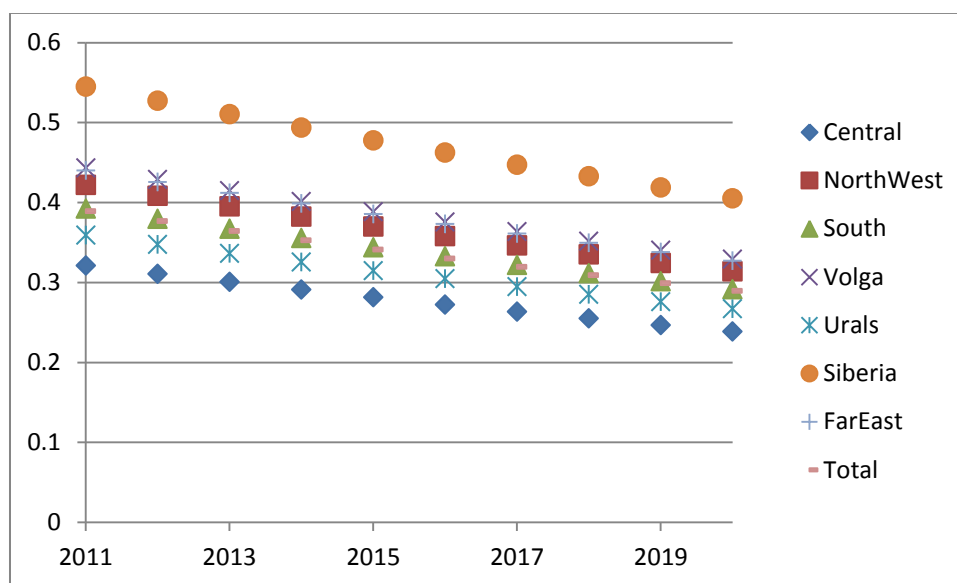


Figure 1: Projections on energy use (in kgoe/USD), source: IEO (year).

2. The SUSTRUS model

2.1 Model description

SUST-RUS belongs to the group of SCGE models, applying a mix of conventional modelling techniques used in standard computable general equilibrium models on regional level. SCGE models typically are comparative static equilibrium models of interregional trade and location based in microeconomics, using utility and production functions with substitution between inputs. Firms can operate under economies of scale in markets with monopolistic competition of the Dixit-Stiglitz (1977) type or under perfect competition. Interesting theoretical simulations with a SCGE model with a land market are found in Fan et al. (1998). These

models are part of the new economic geography school (Krugman, 1991, Fujita, Krugman and Venables, 1999) and have been around for less than a decade.

The present SCGE models have a sophisticated theoretical foundation and rather complex, non-linear mathematics. The latter is precisely the reason why SCGE models are able to model (dis)economies of scale, external economies of spatial clusters of activity, continuous substitution between capital, labour, energy and material inputs in the case of firms, and between different consumption goods in the case of households.

The model represents a real economy with no inflation or banking sector. There is no monetary authority in the model. All prices in the model are relative prices and calculated in terms of the numeraire. A GDP deflator is used as the numeraire in the model. Because there is no banking sector in the model the economic agents do not have the possibility to borrow money and the interest rate is fixed exogenously in the model.

The model utilizes the notion of the aggregate economic agent. They represent the behavior of the whole population group or of the whole industrial sector as the behavior of one single aggregate agent. It is further assumed that the behavior of each such aggregate agent is driven by certain optimization criteria such as maximization of utility or minimization of costs. The model is neo-classical and assumes average costs pricing and no excess profits. The excess profits are normally due to the existence of monopoly or oligopoly on the market. Normal profits of the firms are paid in the form of dividends (return to capital) to the households who own all capital goods in the economy.

The modelling of interregional trade flows is an essential part of the interregional linkage. However, the only data available is the data on the total origin-destination flow of commodities between the regions by type of commodity. There is no information about the trade between the regions in services. There is also no information about differences in the geographical mix of the commodities bought by different sectors and households in the region. Then lack of data results in a simplified structure of the model, where we assume no trade in services between the regions. We also assume that there is no difference in the geographical mix of the commodities bought by various sectors and households in a particular region... Given this assumption, it is possible to represent the decisions of both sectors and households about buying commodities from a particular region as the decision of a representative agent called “wholesaler”. There is one wholesaler per region and per commodity type, who decides upon the geographical mix of commodities. Regional households and sectors further use the composite commodity, which is produced by the

wholesaler. In this way both production sectors and households use the same geographical mix.

The model includes the representation of the micro-economic behavior of the following economic agents:

- At the regional level – one aggregate household type by region, production sectors differentiated by NACE95 classification categories; regional governments; wholesalers differentiated by NACE95 classification categories;
- At the national level - investment banks; federal governments and external trade sector.

Time dynamics

The model is a dynamic, recursive over time model. A recursive dynamic is a structure composed of a sequence of several temporary equilibria. The first equilibrium in the sequence is given by the benchmark year. In each time period, the model is solved for an equilibrium given the exogenous conditions assumed for that particular period. The equilibria are connected to each other through physical and human capital accumulation. Thus, the endogenous determination of investment behavior of households and firms is essential for the dynamic part of the model.

Because of the elaborate regional dimension of the model, it is quite difficult to implement full dynamics. This would drastically increase the number of equations in the model (the number of equations of the static model should be multiplied by the number of time periods) and make it non-manageable. Instead, we use the recursive-dynamic framework which allows for the model size to be manageable.

Households

The behavior of the households is based on the utility-maximization principle. Household's utility is associated with the level and structure of its consumption, level of emissions and the amount of leisure. The household cannot influence the level of emission and takes this as exogenous variables. It is assumed that the utility of household is separable in consumption and leisure.

Each household spends its consumption budget on services and goods in order to maximize its satisfaction from the chosen consumption bundle. Households have substitution possibilities between different consumption commodities. In the model these substitution possibilities are captured by Stone-Geary utility function, which corresponds to the Linear Expenditure

System (LES) of demands. According to the Stone-Geary utility function a household derives its utility only from the amount of consumption, which is higher than the minimum subsistence amount and the elasticity of substitution between commodities is equal to one. In case of all subsistence amounts being equal to zero, the Stone-Geary utility function reduces to the Cobb-Douglas utility function.

Utility of the household is maximized under the budget constraint, where the household's consumption spending is equal to its income minus income tax and the household's savings. Households in the model receive their income in the form of wages, capital, unemployment benefits and other transfers (pensions and other social transfers) from the federal government.

Capital rents are the returns to capital paid to the households by the firms. It is assumed that households own all the firms in the domestic economy. Capital rents are equal to the total capital rents of the economy. In reality each regional household receives its capital rents from a particular region and sector. However the present data availability does not allow for such formulation of the model. There is no data about the flow of investments and corresponding capital rents between the regions of the country.

The level of the unemployment benefits, received by the household, depends upon the level of unemployment of the individuals within the household. The unemployment is modeled according to a simplified wage curve, where households reduce or increase their participation on the labour market, depending on the real market wage.

Russian labour market is known for 1) high participation rates of both sexes 2) a high wage flexibility. Adjustment through negative labour market shocks mostly goes through wages.

Firms

The behavior of the production sectors is based on the profit-maximization principle and is captured by the behavior of the representative firm. The dividends (return to capital) of the sectors are associated with the costs and structure of their intermediate inputs and factor inputs. Intermediate inputs of the firms include energy, various commodities and services. Factor inputs of the firms include physical capital and labour.

At each time period, the instantaneous behavior of the sectors is based on the minimization of the production costs for a given output level under the sector's technological constraint. The level of the sectors' output is equal to the aggregate demand for its production, which reflects of the market equilibrium condition. Production costs of each sector in the model include labor costs by type of labor, energy costs, capital costs and the costs of intermediate inputs.

The sector's technological constraint describes the production technology of each sector. It provides information on how many of different units of labor, energy, capital and commodities, are necessary for the production of one unit of the sectoral output.

The production technology of the sector is represented by the nested Constant Elasticity of Substitution (CES) functions. Nested CES function is quite flexible and allows for different assumptions about the degree of substitutability between the production inputs. Inputs which are easier to substitute with one another are put into the same nest. Inputs which are more difficult to substitute in the production process are put into different nests. The degree of substitutability is the lowest on top of the nested CES function and the highest at the bottom of it. All production inputs in the CES tree have a certain degree of substitutability between each other and it depends on their relative position in the tree. In accordance with their production technology, sectors have substitution possibilities between different intermediate inputs and production factors.

At the top level of the CES function sectors can substitute between intermediate inputs and the aggregate capital-labour-energy bundle. At the second nest they can substitute between capital-labour and energy. At the lowest nests they can substitute between the use of different energy types, capital and labour.

Production sectors produce according to perfect competition rules or according to the Dixit-Stiglitz framework of monopolistic competition. Under this framework, it is assumed that each sector consists of a number of identical firms, each producing a unique specification of a particular commodity. The same type of the commodity, produced by an individual firm, is slightly different from the same type of commodity, produced by other firms inside the sector. These differences in the commodity specification then give individual firms a certain monopolistic power over the consumers. Consumers prefer a certain specification of the commodity and, hence, they are prepared to pay a bit more for it. The monopolistic power of the individual firms results in the deviation from the marginal costs pricing rule of perfect competition. The producer prices are now equal to the sector's average production costs and depend upon the number of the individual firms, which operate on the market. The sectoral variable costs are equal to the marginal output costs multiplied by the sectoral output level. The sectoral fixed costs depend upon the number of the individual operating firms and are equal to the number of firms inside a sector multiplied by the fixed costs per firm.

Sales

Domestic regional sales of each type of commodities or services are composed of the commodities and services produced by the domestic sectors, those imported from other regions and those imported from the rest of the world. According to the Armington assumption, the same type of commodity produced by the domestic sectors, imported from the other regions or imported from the rest of the world has different specifications and, hence, cannot be treated as a homogenous good. Domestic consumers have different preferences for these specifications and can substitute between them in case the relative prices of the specifications change. The substitution possibilities between these commodities specifications are captured by a CES function that varies between the types of commodities. This means that the shares in which commodity are bought from the domestic producers, from other regions and from the rest of the world are determined by the relative producer prices of the commodity, transport and trade costs.

All regional households and firms purchase the same geographical mix of commodities, which is produced by the commodity-specific wholesaler in each region. This mix consists first of commodities bought from different regions and further from commodities bought from different producers within the sector producing the commodity (this represents different varieties). The assumption that all economic agents in the region consume the same geographical mix of commodities does not reflect the reality. As mentioned before, this assumption is made because of the lack of the data about the trade flows between the regions.

The equilibrium prices of all commodities and services are defined by the market equilibrium conditions. Under the market equilibrium the sum of demands for a particular commodity and service is equal to the sum of its supply.

Savings

The model incorporates the representation of investment and savings decisions of the economic agents. Savings in the economy are made by firms, households, government and the rest of the world. The total savings accumulated at each period of time are invested into accumulation of the sector-specific physical capital, which is not mobile between the sectors.

The total investment into the sector-specific capital stock is spent on buying different types of capital goods such as machinery, equipment and buildings. The concrete mixture of different capital goods used for physical investments is determined by the maximization of the utility

of the investment agent. This is an artificial national economic agent responsible for buying capital goods for physical investments in all the domestic sectors.

Governments

The model incorporates the representation of the federal and regional governments. The governmental sector collects taxes, pays subsidies and makes transfers to households, production sectors and to the rest of the world. Tax revenues are shared by the national and regional governments according to the certain rates determined from the base year data. The federal and regional governments consume a number of commodities and services, where the optimal governmental demand is determined according to the maximization of the governmental consumption utility function. We use a Cobb-Douglas utility function in the model. Its maximization results in the demand rules, which says that the expenditure share of different commodities and services purchases by the government stay constant over time. The model incorporates the governmental budget constraint. According to this constraint the total governmental tax revenues are spend on subsidies, transfers, governmental savings and consumption. There are transfers between the regional and national governments.

Finally, the model includes the trade balance constraint, according to which the value of the country's exports plus the governmental transfers to the rest of the world are equal to the value of the country's imports.

2.2 The regional dimension of gas production and consumption

SUSTRUS is a regional model on the level of the Russian Federations. Therefore we have a look at some basic facts of natural gas production on the regional level. In Figure 2 below, we show how the production of natural gas is divided between the 7 federal districts of the Russian Federation. We see that the main producing regions are the Central, Volga and Ural regions of the Russian Federation, each producing about a quarter of the total production. South, North and Siberia produce much less natural gas and the Far East has almost no production.

Comparing this with Figure 3, which gives the prices of natural gas in each region, according to Goskomstat (year), we see that natural gas prices are relatively higher in regions with less gas production, the highest price being in the South region.

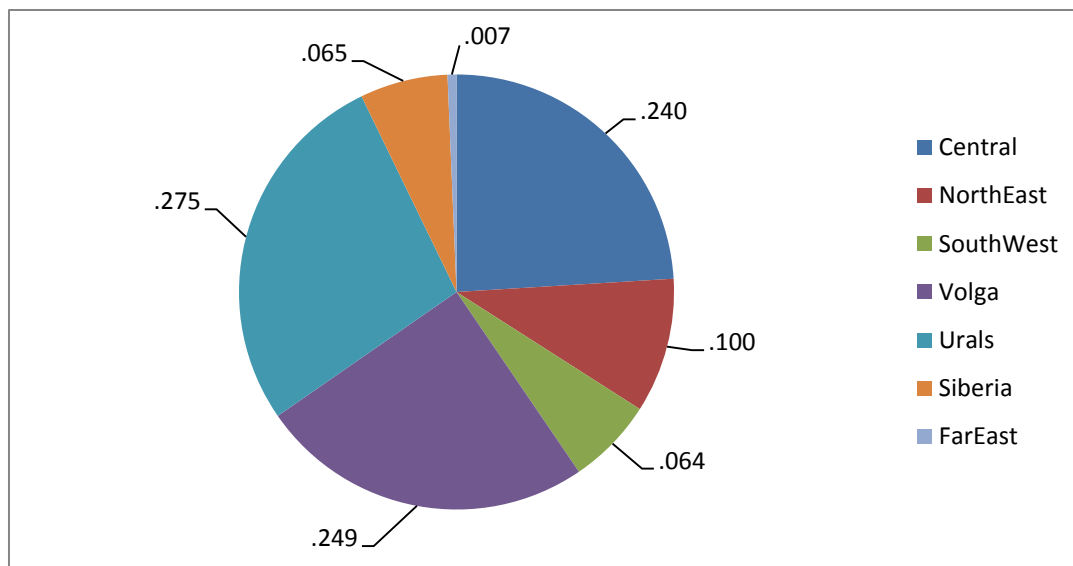


Figure 2: share of natural gas production by region (source: Goskomstat 2006)

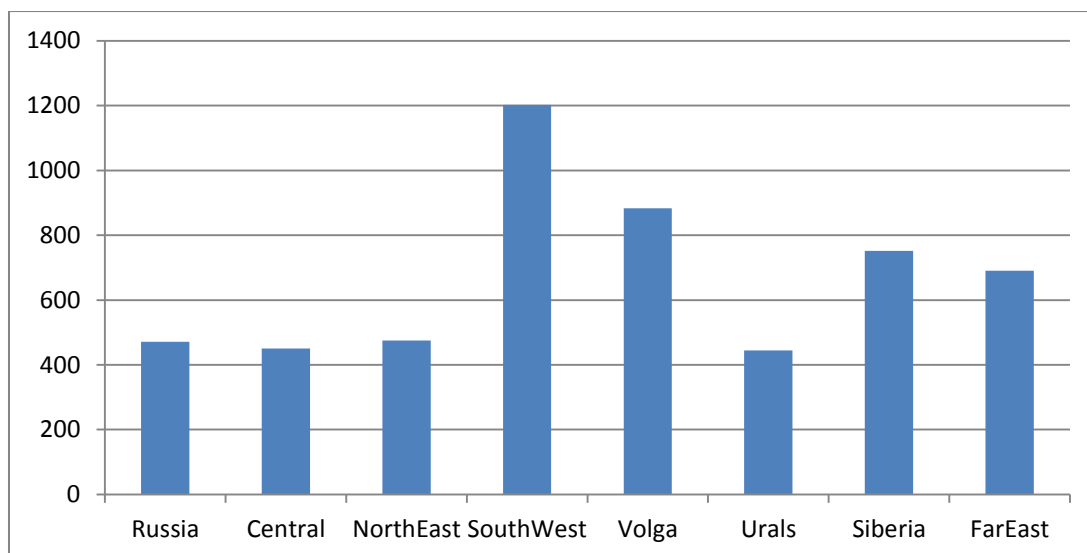


Figure 3: Natural gas price by region (production price), rubles/m3 (source: Goskomstat 2006)

2.3 Set-up of the simulation

In this simulation we will mimic the current proposal of the Russian government, to increase prices of natural gas on the domestic market annually with 10% from 2012 onwards.. To simulate the impact of such a change in prices, we assume that the government systematically increases taxes on final and intermediate consumption of natural gas. This is not a self-evident assumption. The domestic market of natural gas is tightly government controlled and only little information is available on taxation, production cost of natural gas and competition with

independent producers. In fact, the Russian government mainly applies price regulation and production subsidies to retain low domestic gas prices.

In the rest of this chapter we will work with the case of direct taxation of the natural gas product. The reason for this is, that it leads to the least amount of distortion with other markets. In fact, this distortion is something we wish to avoid, as we want to focus on the effects of price changes on the domestic market and the resulting changes in energy use and energy efficiency. Also, we have only limited information on the real production cost of natural gas.

We will perform a dynamic simulation with the SUSTRUS model, where the domestic price of gas increases with 10% each year, by increase of the tax rate on consumption.

We will compare 3 situations:

1. **Scen H**: only the consumers experience a rise in the domestic price of gas
2. **Scen F**: only the firms face the increase in taxes
3. **Scen HF**: both consumers and firms face an increase in the price level of gas.

Our simulation will run from 2012 to 2020. In each year the price of gas goes up with 10%, compared to the last year. This means that by 2020 the price of gas will have doubled, compared to the base year. The chosen closure of the model is via the adjustment of foreign savings. The government balances its budget by increasing or decreasing public savings.

3. Results

Macroeconomic implications

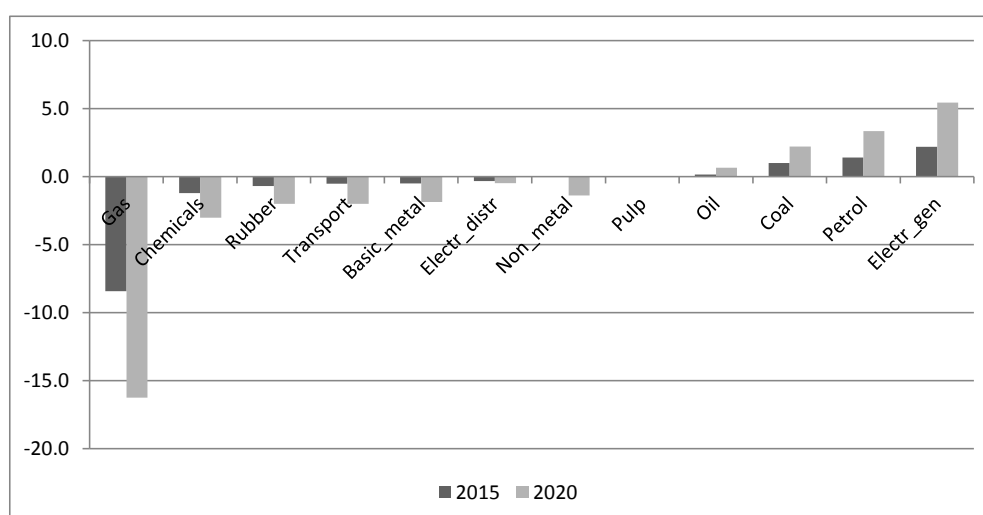
We start the interpretation of our results with macroeconomic implications of gas price increases (Table 1). A policy option aiming at the households' taxation (*Scen_H*) has an overall positive impact at the macroeconomic level according to the key indicators such as real GDP per capita, tax revenues and investments. The main argument behind these effects is that large-scale distortions are removed. Albeit these mechanisms drive the results under the alternative scenarios as well (*Scen_F* and *Scen_HF*), there are substantial adverse sectoral adjustments which let export and GDP level decrease in comparison to the BaU.

Table 1: Main macroeconomic impacts (% change from BaU in 2020)

Dimension	Indicators	Scen_H	Scen_H	Scen_HF
<i>ECONOMY</i>	GDP capita	1.74	-1.70	0.27
	Herfindahl	-0.01	-0.15	-0.19
	Invest	4.64	2.15	5.80
	Price Index	-0.18	-0.75	-0.84
	Tax Revenues	0.98	1.87	2.13

Sectoral effects

To economize space, depicts sectoral implications for energy producing and selected energy-intensive industries in the year 2020, focusing on the scenario in which we simulate firm's higher gas prices. As expected, switching from gas to other energy goods induces rather substantial production losses in the gas sector – up to roughly 15% in 2020 in comparison to the BaU. Coal and petroleum producing industries together with the power generating sector gain, with the latter expanding its production level by impressive 5% in comparison to the “doing nothing case”. Energy-intensive industries suffer from a loss in competitiveness if we track the adjustments in output levels but production losses are not likely to be high even for significant gas price increases. If policy discriminates gas pricing in favour of industrial sectors and taxes households instead, these losses can be ameliorated and even overcompensated.

**Figure 4: Sectoral implications for selected industries (% change from BaU)**

Trade implications

Trade implications (table) can be summarized as follows:

- Foreign direct investment increase substantially in relative terms, however this shift is not so large in absolute terms (the baseline for foreign investments is only 1.5% of GDP)
- The trade surplus slightly increases, especially when only firms are taken up in the tax scheme.
- Interregional trade is negatively affected, as a relatively large part of the interregional trade flows is natural gas.

Table 2: Trade implications (% change vs. BaU in 2020)

Dimension	Indicators	Scen_H	Scen_F	Scen_HF
<i>TRADE</i>	Foreign Invest	55.44	58.98	57.60
	Trade Balance	0.20	0.82	0.00
	Interregional trade	-1.36	-0.59	-1.99

At the sectoral level, it can be claimed that higher domestic prices for natural gas, would stimulate exports of gas and lead to increased earnings for industry and government. In **Error! Reference source not found.** we give an overview of the adjustments to exports and imports by 2020, in absolute values of 2006. In all cases export of natural gas is stimulated in real terms, however the adjustment mechanism is much more complex than would be expected. Together with natural gas, exports of other energy carriers increase. This is caused by an overall decrease in energy consumption due to the increase in the gas price. The reduction in domestic demand for energy leads to higher exports to the rest of the world. Imports of machinery counteract the effect of increased export of energy on the international market.

Increasing the price of natural gas for domestic firms leads to a reduction in total exports. While the export of energy carriers (oil, petrol, natural gas) and the trade and transport sector increases³, the export of the manufacturing sectors decreases due to higher production cost⁴.

³ The trade and transport sector captures a part of the surplus in trade margin and transport costs, caused by increased export of energy carriers.

⁴ Increased price of electricity and natural gas

Table 3: Exports and imports by industry/product compared to baseline in 2020, difference in absolute value (billions of rubles of 2006).

	Exports			Imports		
Sectors	Scen_H	Scen_F	Scen_HF	Scne_H	Scen_F	Scen_HF
<i>Gas</i>	<i>9.82</i>	<i>55.76</i>	<i>68.62</i>	<i>-1.16</i>	<i>-8.54</i>	<i>-10.12</i>
Oil	21.17	-23.68	-7.91	0.56	1.68	2.29
Petrol	15.28	26.47	42.38	0.91	4.21	5.37
Trade	38.06	41.97	75.6	0	0	0
Machinery	4.86	-8.21	-6.5	69.17	-2.23	63.76
Basic metals	17.24	-63.11	-48.79	11.8	1.85	16.97
Other	22.54	-37.59	-25.42	64.24	-49.18	15.28
Total	128.97	-8.39	97.98	145.52	-52.21	93.55

Environmental implications:

Table 3 illustrates changes in energy efficiency (EE) across Russian regions for 2015 and 2020, respectively. The energy efficiency improves as the indicator decreases; the energy efficiency deteriorates as the indicator increases. The magnitude of changes in EE depends on (i) the stringency of gas price increases advancing towards the end of the decade, (ii) the energy intensity of a region in the reference case and (iii) the coverage of economic agents subjecting to the gas price increases.

Table 4: Economy-wide and regional energy efficiency improvements (% change from BaU) ⁵

	2015			2020		
	Scen_H	Scen_F	Scen_HF	Scen_H	Scen_F	Scen_HF
RF	0.0	-3.4	-3.8	-0.2	-5.4	-6.3
Central	0.2	-3.0	-3.2	0.1	-4.8	-5.4
North West	0.2	-4.6	-4.8	0.3	-7.9	-8.4
South	0.1	-1.9	-1.9	0.0	-3.0	-3.2
Volga	0.0	-2.5	-2.8	-0.3	-3.8	-4.6
Urals	-0.3	-4.7	-5.7	-0.9	-7.1	-8.9
Siberia	0.1	-3.6	-4.1	-0.2	-5.8	-6.8
Far East	0.0	-4.9	-5.3	-0.3	-8.5	-9.5

⁵ RF = Russian Federation

Probably one of the most important results of our simulations is that rising household's gas prices will leave economy-wide energy efficiency virtually unchanged in 2015 in comparison to “doing-nothing case”. This is due to a rather small fraction of households' gas consumption in total gas consumption in Russia.

Table 4 further shows that at the regional scale there are even some adverse implications in terms of decreasing energy efficiency, though they are not likely to be substantial. This result can be mainly explained by indirect effects working through changes in prices on the Russian gas market. The cutback in gas demand by households implies a tiny drop in prices which is, however, of a magnitude sufficient enough to provide incentives to the industrial producers to use a bit more of cheaper energy in the production process. As a result, the regional energy efficiency deteriorates, with only one exception: in Urals region direct effects from households' energy reduction are likely to outweigh the indirect effects from the increasing demand by industrial producers.

Our simulations further highlight that substantial improvements in EE are feasible only if government charges industrial producers with higher gas prices. The regional rate of EE improvement varies then between 1.9% and 4.9% in 2015 and between 3.0% and 8.5% in 2020. The improvement of energy efficiency is highest vis-à-vis the BaU levels when both households and firms face increasing gas prices.

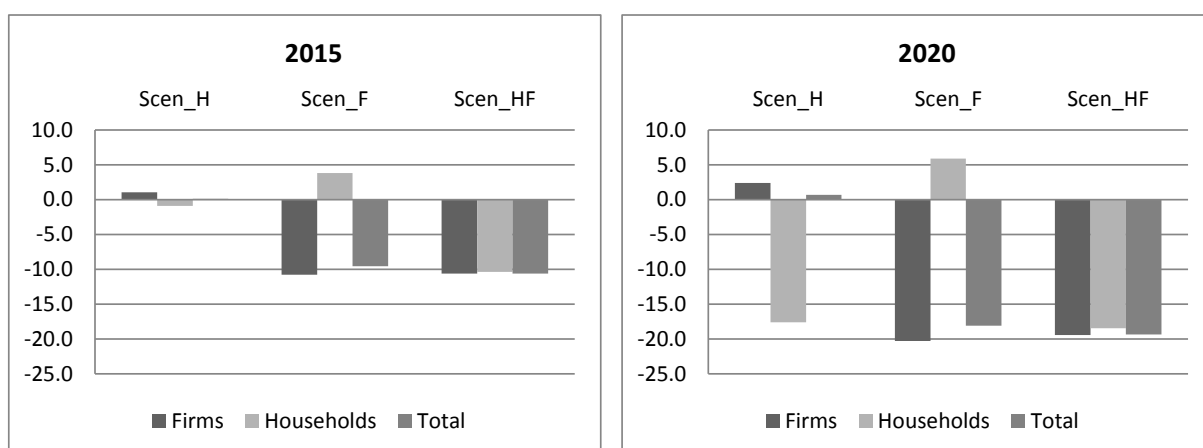


Figure 5: Economy-wide carbon emissions (% change from BaU)

Figure 5 visualizes how the level of CO₂ emissions – from households, firms and totals (economy-wide emissions) – reacts to changes in energy efficiency. Under the most extensive scheme in *Scen_HF*, the large-scale emissions reductions of about 10% (20%) compared to

the BaU in 2015 (2020) can be achieved. Thus, the gas price liberalisation will bring Russia on a substantially more sustainable path in terms of CO₂ emissions but only under the prerequisite that industrial producers will advance in terms of the energetic modernisation. Limiting the policy to the household's side will barely cause any measurable improvements in emissions levels.

Table 5: NOX, PM and SOX emissions

Dimension	Indicators	Scen_H	Scen_F	Scen_HF
ENVIRONMENT	NOX emissions	0.95	-31.25	-32.03
	PM emissions	-0.69	2.08	1.37
	SOX emissions	-0.43	4.84	4.48

Finally, while by 2020 the amount of CO₂ emissions may fall by 20 % and the amount of NO_x by 30%, the economy becomes more intensive in coal, which leads to higher SO_x and PM emissions (Table 5)

Social impacts:

The main results from Table 6 can be summarized as follows:

- The Atkinson and Gini indices report a slight rise in inequality when consumers are taken up in the scheme.
- The Kakwani index points towards a decrease in progressivity in the tax system with 5-10% according to the simulation.
- Unemployment is not expected to rise substantially and could even fall.

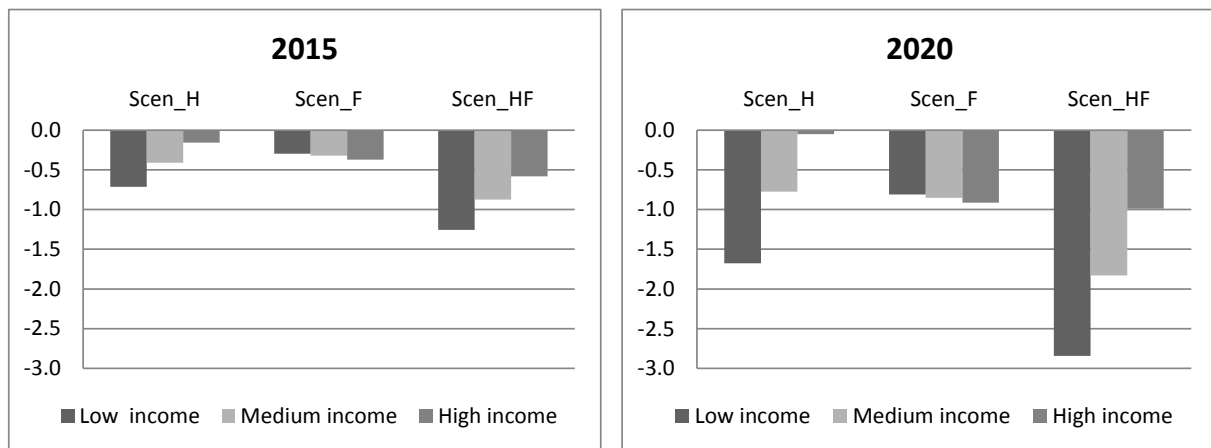
Table 6: Social implications (% change vs. BaU in 2020)

Dimension	Indicators	Scen_H	Scen_F	Scen_HF
SOCIAL	Atkinson	0.21	-0.25	0.09
	Consumption budget	-0.89	-0.30	-1.22
	Gini	0.03	-0.19	-0.06
	Kakwani	-6.22	-5.62	-10.19
	Poverty Intensity	-0.15	-0.15	-0.35
	Unemployment	-2.80	0.74	-1.96
	Unemployment Low skill	-1.48	0.58	-0.90
	Unemployment Med. skill	-3.74	0.35	-2.84
	Unemployment High skill	-2.38	2.77	-1.12
	Welfare	-0.44	-0.88	-1.45

Dimension	Indicators	Scen_H	Scen_F	Scen_HF
	Welfare Low income	-1.68	-0.81	-2.84
	Welfare Medium income	-0.78	-0.85	-1.83
	Welfare High income	-0.03	-0.91	-0.99

Figure 6 visualizes distributional impact assessment of gas price increases for low-, medium- and high income households. We find that deregulating natural gas pricing is indeed a regressive policy if prices are gradually increased for consumers only. From the distributional point of view, charging firms with higher gas prices might be a superior strategy as it will have a moderate and progressive impact on citizen's welfare in comparison to “doing nothing case”.

Figure 6: Welfare impacts for different types of households (% change from BaU)



4. Conclusions

In this paper we have taken the low price of natural gas on the Russian domestic market as a starting point for our analysis. We have implemented an ad-valorem tax, starting in 2011, increasing the price of natural gas for consumers, industry and both with 10% until 2020. This type of scheme was chosen, as it led to the least amount of distortion with other sectors in the economy. Our simulations show that increasing the price of natural gas for consumers alone, would not be effective in reducing emissions in the Russian Federation. The reason is that emissions would shift from the residential sector to the industries. A tax on industry only would be more effective to decrease pollution from natural gas, but would also lead to some ‘leakage’ to the residential sector on longer term. The government would best consider a

mixed scheme, where both consumers and industry share in the burden of increased price of natural gas.

The environmental benefits of higher gas prices are substantial and could lead to a decrease in emissions by 20% in 2020 compared to BaU. Also the emission of NO_x would decrease substantially. Oppositely however, a tax on natural gas would lead to higher consumption of coal, which (at longer term) would lead to substantially higher SO_x and PM emissions under ceteris-paribus conditions. Therefore, while increasing the price of natural gas would be beneficial for the environment, it would also be important to consider the negative environmental impact of a shift to coal or petrol.

On the social side, the model indicates that taxation of natural gas for consumers is regressive and lead to an increase in inequality. This could best be considered, as the impact on welfare of the lowest income classes is 2 to 3 times higher than on the highest income classes. A fair tax scheme would take this into account and could involve cuts or exemptions for the lowest income classes. This would not really decrease the effectiveness of the tax scheme, as the industry remains the biggest consumer of natural gas in the Russian economy.

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