The sectoral effects of global climate policy on the Russian economy

Abstract

Key words: Russia, CGE model, climate policies, energy

Contents

1. Introduction

COP21 meeting in Paris ended up with a global climate (non-binding) agreement, which proposes an ambiguous target of 1.5-2 °C. Among other countries, Russia proposed a reduction in GHG emissions. Russia's pledge submitted to the UN accounts for a 25-30% reduction in GHG emissions by 2030 compared to 1990 (Carbon Brief[1], 2015). At present, Russia is one of the world's largest producers of GHG emissions; Russia's share in global GHG emissions accounted approximately for 5% in 2012 (WRI[2], 2012).

In fact, Russia might not need any climate policy instrument, such as carbon taxes and carbon permits, to achieve a substantial reduction in GHG emissions. This is because, as many other economies, the Russian economy is distorted by pre-existing subsidies imposed on domestic energy consumption. For example, Russia imposes high export taxes on crude oil, oil products, and gas. Furthermore, domestic gas prices are regulated in Russia and they are substantially lower than export netback prices. Export taxes and the regulation of gas prices operate as implicit subsides to domestic consumers. Economic intuition suggests that the elimination of those pre-existing distortions might be a more efficient approach, rather than to introduce new distortions (e.g., carbon taxes). In other words, eliminating energy subsidies might not only increase economic efficiency, but also induce a reduction in GHG emissions and encourage investments in energy saving technologies.

As a large consumer and exporter of fossil fuels, the Russian economy clearly will be affected by domestic and foreign climate policies as well as foreign economies will be affected by the Russian climate policy. Recently, a few publications addressed economy-wide effects from Russia's energy policy (e.g., Heyndrickx[3] et al., 2012). Yet their analyses are based on single-country models, which are unable to depict the response of other economies as well as terms-of-trade effects. Moreover, those studies do not show, how the Russian economy might be affected, when other countries implement stricter climate policies. This study aims to shed light on this politically important issue.

The main objective of this paper is to analyse the economy-wide effects resulting from a stricter climate policy in Russia and the rest of the word. To analyse those effects, we use a large-scale numerical model, which allows to depict the interaction between output and factor markets as well as trade flows among countries. Our analysis is based on a multi-region multi-sector computable general equilibrium (CGE) model, GRACE (Aaheim and Rive[4], 2009), which has been calibrated around Version 9 of the GTAP database.

From an economic point of view, what matter is overall welfare effects arising from a policy, and therefore, many CGE studies typically focus on welfare effects. Yet, competitiveness and income distribution effects are also vital to policy-makers. In this analysis, we neglect the issue of income distribution, due to data availability, but we focus on sectoral effects, showing the effects on production and consumption patterns among regions. The rest of the paper is organized as follows. Section 2 provides an informal description of the model. Section 3 presents the results and discussion. Section 4 concludes.

2. Database and model

2.1 Database

For our analysis, we use Version 9 of the GTAP database (Narayanan[5] et al., 2015), which depicts the global economy in 2011. Version 9 of the GTAP database provides data on 140 regions and 57 commodities. We aggregated all regions into three region: RoW, EU28, and Russia, and all commodities are aggregated into 12 commodities.

We found some inconsistency between the energy tax system depicted in Version 9 of the GTAP and that currently applied in Russia. For example, according to Version 9 of the GTAP database, the export tax on gas in Russia was over 300%, whereas according to the Russian Tax Code it is 30%. Furthermore, Version 9 of the GTAP database shows high sale taxes on gas consumption, whereas domestic gas prices are administratively regulated in Russia and they are substantially lower than export netback prices. In other words, domestic consumers of gas are indirectly subsidised in Russia via low consumer prices. Therefore, we adjust the database to correct for the appropriate export tax rate on gas and to incorporate domestic gas subsidies.

2.2 Model

Our analysis is based on a multi-region multi-sector CGE model, GRACE (Aaheim and Rive, 2005), which was calibrated around Version 9 of the GTAP database. CGE models are widely used for macroeconomic economic analyses, especially when interactions between factor and output markets and trade effects are crucial. Another advantage of using a CGE model is that it allows to analyse different policy simulations in the presence of pre-existing distortions such as taxes.

In GRACE model, following Mathiesen[6] (1985) and Rutherford[7] (1995), economic equilibrium is formulated as a mixed complementarity problem (MCP) of inequalities and associated variables. In order to achieve equilibrium, three general equilibrium conditions have to be satisfied: (1) zero profit, (2) market clearing, and (3) income balance. The model is coded in GAMS/MPSGE (Brooke[8] et al., 1996; Rutherford[9], 1998) and solved by suing the PATH solver (Dirkse and Ferris[10], 1995). Production technologies as well as consumption preferences are depicted, using Constant Elasticity of Substitution (CES) functions.

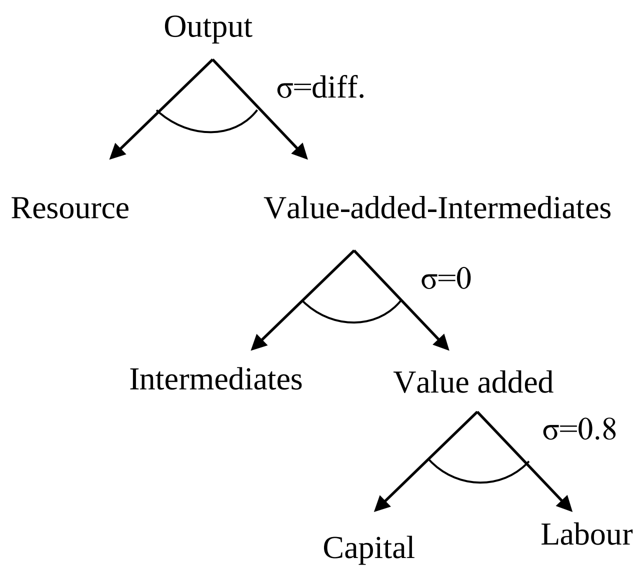
Production

Firms are assumed to maximise their profits subject to production technologies. Production technologies are described by nested separable CES functions. Output is produced by using primary input factors (i.e., labour, capital and resources) and intermediates. The use of primary input factors and intermediates are subject to taxation. Moreover, there is an output tax. Firms are assumed to operate under perfect competition. Production of resource-based commodities, such as minerals and fossil fuels, includes a sector-specific factor that is fixed in supply. Two nesting structures are distinguished: primary energy (Fig. 1) and non-energy (Fig. 2) sectors.

For primary energy sectors at the first level, output is described by a standard CES function over the value-added-intermediates aggregate and the natural resource, with a substitution elasticity calibrated to achieve a desirable supply elasticity. Supply and demand elasticities for energy resources are the main drivers of the results in our policy simulations. In the empirical literature, there is no much consensus on demand and supply elasticities for energy resources. For example, Paltsev[11] et al. (2005), Caron[12] et al. (2012), Rausch[13] et al. (2010) employed a supply elasticity of 1.0 for coal and gas, and for crude oil, it was 0.5. Burniaux and Chateau[14] (2011) used a supply elasticity for crude oil and gas equaling 1.0 and 0.8, respectively, whereas coal was assumed to be more elasticity, with a supply elasticity of 10. In our analysis, we use the values employed by Paltsev et al. (2005).

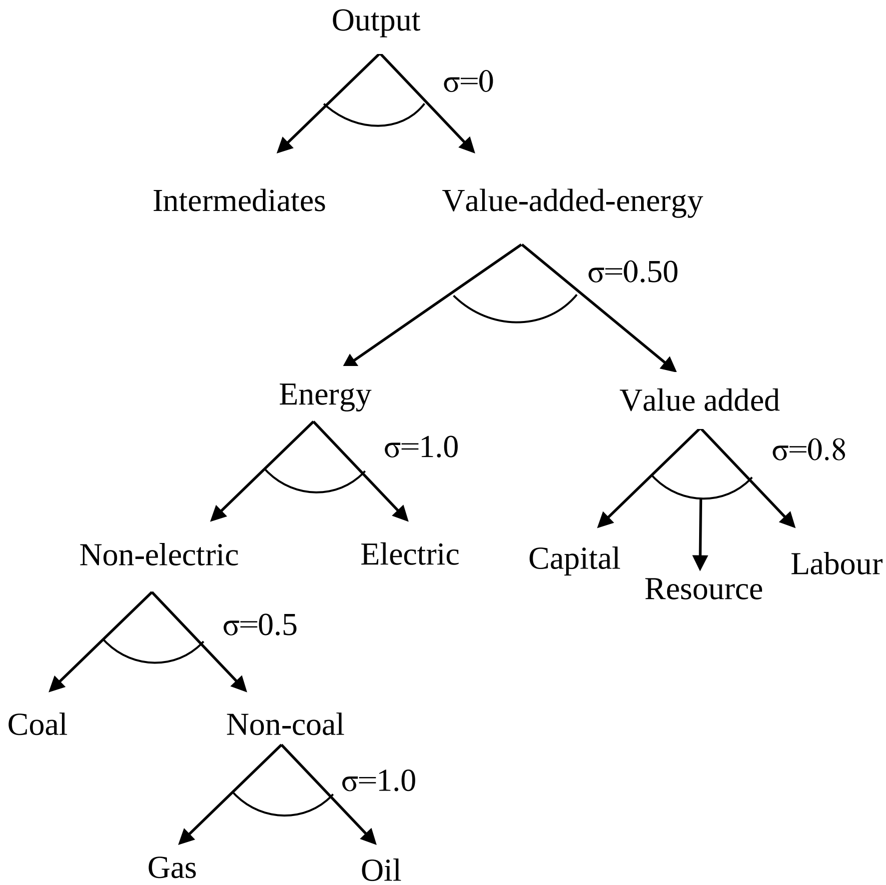
At the second level, the value-added-intermediates aggregated is depicted by a Leontief function over intermediates and the value-added aggregate. The value-added aggregate is a standard CES function over capital and labour. The substitution elasticity between capital and labour is another important parameter, which determines technological flexibilities of producing sectors. The empirical literature typically rejected the hypothesis of a Cobb-Douglas function over capital and labour, showing that the substitution elasticity tends to be less than unity (e.g., Arrow[15] et al., 1961). For our analysis, we assume a substitution elasticity equalling 0.8.

Fig. 1. Nesting structure of primary energy sectors.



For non-energy sectors, output is described by a Leontief function over intermediates and the value-added-energy aggregate. At the second level, the value-added-energy aggregate is a standard CES function over the energy aggregate and the value-added aggregate, with a substitution elasticity of 0.5. Depicting the energy aggregate, we follow the GTAP energy model (Burniaux and Truong[16], 2002). The energy aggregated is formed from a Cobb-Douglas function over electricity and non-electric energy inputs. The aggregate of non-electric energy inputs is depicted by a standard CES function over coal and non-coal, with a substitution elasticity equalling 0.5. The aggregate of non-coal energy inputs is described by a Cobb-Douglas function over gas and oil. The value-added aggregate is depicted by a standard CES function over capital, labour, and a resource (if any), with a substitution elasticity of 0.80.

Fig. 2. Nesting structure of non-energy sectors.



Trade

Total domestic output is distributed between export and domestic markets. Domestic and export supply are assumed be perfect substitutes in production. There are export taxes on exported commodities. Imported and domestically produced commodities are assumed to be imperfect substitutes. Following the Armington approach (Armington[17], 1959), we use a CES function to depict imperfect substitutability between imports and domestically produced goods so that domestic and imported goods build the so-called Armington aggregate. A two-level Armington aggregate is built. The first level depicts substitution in imports between regions. The second level describes substitution between imported and domestically produced commodities. There are import tariffs on imported commodities. The Armington elasticities of substitution are taken from the GTAP database, which are reported in Supplementary Material, Appendix A. The Armington aggregate is distributed then between private, public, investment, and intermediate consumption.

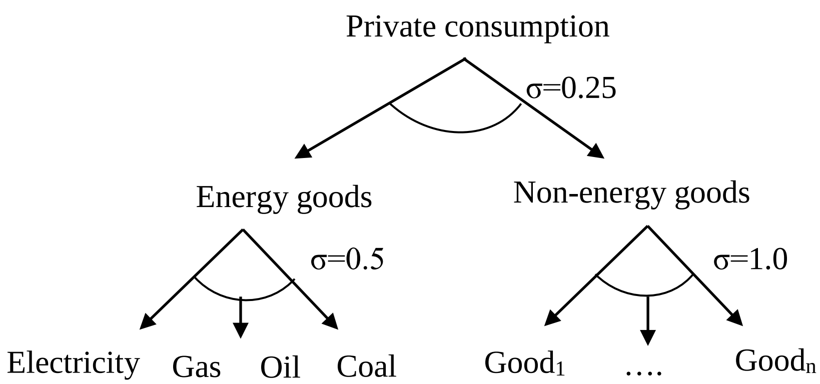
Saving-Investment

Because we run a static model, we implement an investment-driven closure, i.e., investments are fixed in real term. This implies that the investment-savings account is cleared by changes in the saving rate. Therefore, all adjustments operate via changes in private and public consumption.

Region households

In the core version of the model, private households and the government account in each region are depicted by a representative household, which receives factor payments (i.e., labour, capital, and resource income) and tax revenues and spend them on private and public consumption and savings. The nesting structure of private consumption is illustrated in Fig. 3.

Fig. 3. Nesting structure of private consumption.



Factor markets

Labour, capital and natural resources are assumed to be immobile across regions, yet labour and capital are mobile across sectors. To investigate the relevance of international capital mobility, we assume perfect international capital mobility is some experiments.

3. Results and discussion

We conduct four policy simulations.

SN1: An elimination of domestic gas subsidies in Russia (i.e., the gas-price reform)

SN2: An elimination of domestic gas subsidies and export taxes on gas and oil in Russia (i.e., the energy-tax reform)

SN3: A 32% reduction in CO_2 emissions in the EU and a 19% reduction in CO_2 emissions in the RoW

SN4: A 32% reduction in CO_2 emissions in the EU and a 19% reduction in CO_2 emissions in the RoW and an elimination of domestic gas subsidies and export taxes on gas and oil in Russia

The first two experiments aim to show the macroeconomic and sectoral effects resulting from the implementation of an energy tax reform in Russia, where implicit subsidies on energy consumption, such as the regulation of domestic gas prices and export taxes on gas and oil, are eliminated. The third experiment reveals the economy-wide effects arising from the implementation of global climate policy. The global climate policy in our analysis is defined as a 20% reduction in CO2 emissions. The global climate agreement, which was achieved in Paris at the COP21 meeting, aims at stabilizing the increase in global temperature at 1.5-2 °C. RCP 2.6 describes emission scenarios for a 2 °C increase in temperature (van Vuuren[18] et al., 2011). According to RCP 2.6, world's total CO_2 emissions in 2010 accounted for 8.821 PgC/yr and in 2030 it should be 7.157 PgC/yr, i.e., world's CO_2 emissions should be reduced by approximately 19%. According to the *New Policies Scenario* of World Energy Outlook 2015 (OECD/IEA, 2015), EU's CO_2 emissions will be reduced by approximately 32% by 2030 compared to 2011. For simplicity, in our analysis, we reduce EU's CO_2 emissions by 32%, whereas CO_2 emissions from the RoW are reduced by 19%.

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