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Carbon taxation and market structure: A CGE analysis for Russia

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HIGHLIGHTS

- Substituting carbon taxes for labour taxes in Russia can yield a double dividend.
- The labour supply elasticity and substitution possibilities between factors are crucial.
- Introducing carbon taxes can exacerbate distortions from imperfect competition.
- Increases in energy costs result in higher mark-ups because of less competition.

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ABSTRACT

Russia is one of the world's major sources of carbon based energy as well as one its most intensive users. Introducing carbon taxes can lead to a reduction in emissions and encourage investment in energy efficiency. We investigate the economic effects of carbon taxes on the Russian economy under perfect competition and a Cournot oligopoly in output markets. The main findings are: (i) substituting carbon taxes for labour taxes can yield a strong double dividend in Russia; however, welfare gains strongly depend on the labour supply elasticity and elasticities of substitution between capital, labour, and energy. (ii) Under the assumption of a Cournot oligopoly with homogenous products and symmetric firms in the markets for natural gas, petroleum and chemical products, metals, and minerals, welfare costs of the environmental tax reform can be higher than under perfect competition. This is because introducing carbon taxes leads to a reduction in already sub-optimal output, thereby exacerbating pre-existing distortions arising from imperfect competition. (iii) Furthermore, increases in energy costs can result in higher mark-ups in some markets because of less competition resulting from firms' exit.

1. Introduction

Russia is not only one of the world's major sources of carbon based energy – coal, oil and gas – but is also one the most intensive users of energy. Furthermore, Russia accounts for a disproportionately large share of global carbon emissions—some from 5% to 6% of global carbon emissions (EIA, 2011); even after making allowance for climatic conditions. In large part, the high carbon emission rates are consequence of outdated and inefficient technologies, a legacy of the Soviet era, reinforced by the low cost of energy (Bashmakov, 2009). For example, to produce one dollar of GDP, Russia requires by 28% more energy than Canada, a country with similar climatic conditions, and twice more than European countries on average (EIA, 2011). It has been estimated (World Bank, 2008) that Russia could reduce its use of primary energy use by some 45%, with consequent economic and environmental benefits.

Much attention has been given to the issue of energy efficiency in Russia. Improvement of energy efficiency is one of the most important aspects of the Russian energy policy (Ministry of Energy, 2010). However, energy using technologies are typically embedded in capital equipment, e.g., power stations, smelters, etc., and buildings which have long productive lives, and hence the pace of technological change is inevitably a costly and long process. It raises concern that there is underinvestment in energy efficiency in Russia, i.e., an energy efficiency gap exists between the current and the social optimal energy use (Kozuchowski, 2008). There are different reasons which can slow down technical modernization. The replacement of technologies in Russia is particularly slow due to a combination of non-market failures – underestimation of adoption costs, high discount rates, and heterogeneity of energy users – and market failures—lack of information, principle-agent problems, and low energy prices because of inefficient price regulation and non-internalized environmental externalities (World Bank, 2008). On grounds of economic efficiency, only the

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existence of market failure can provide justifications for government intervention (Jaffe and Stavins, 1994a, 1994b).

This analyses focuses on non-internalized negative externalities considered as one of the reasons for the high energy/carbon intensity in Russia. Environmental taxes are small in Russia: for example, environmental payments paid by thermal power generation companies account for less than 0.1% of their total production costs, being considerably lower compared to many developed countries (EFA, 2009).

Carbon taxes are one such Pigouvian tax and in Russia they would, potentially, address concerns on several fronts simultaneously. In the short to medium term they would, *inter alia*, (i) reduce CO_2 and other emissions stemming from the use of energy commodities, (ii) induce energy users to optimize the energy efficiency of existing plants, (iii) substitute lower emission energy sources for higher emission sources and (iv) induce the adoption of passive energy saving technologies, e.g., improved insulation. In the longer term, the increased cost of primary energy products should both accelerate the rate of technological replacement and induce technological progress (Ruttan, 1997; Newell et al., 1999; Popp, 2002).

Carbon taxation is not high on the political agenda in Russia. Nevertheless, recently there has been a political discourse in Russia regarding increases of environmental payments (Kozuchowski, 2008; MNRERF, 2011). Although Russia has signed the Kyoto protocol and is subject to limits on its total carbon emissions, Russia currently is substantially below its limit and there would be no urgent need for a reduction of actual CO_2 emissions (UNFCCC, 2010). According to Article 17 of the Kyoto protocol, Russia may sell part of its rights to emit CO_2 to other countries as part of the international carbon trade (UNFCCC, 2006). This may constitute an additional benefit from increasing carbon taxes in Russia which is politically discussed (RT, 2010).

Furthermore, according to the environmental taxation literature, an introduction of environmental taxes is often related to the concept of a strong double dividend, where substituting environmental taxes for other distortionary taxes can improve not only the environment, but also this can reduce efficiency costs of the tax system (Goulder, 1995). The occurrence of a strong double dividend is ambiguous and this depends, *inter alia*, on the tax system, economic structure, households preferences, and revenue recycling strategies (Goulder, 2002).

In case of environmental taxes, the revenue recycling policy becomes an important aspect. Compared to other possible revenue-recycling strategies, a reduction in labour taxes via revenues from environmental taxes is often considered as desirable, especially for Western economies, since it also addresses unemployment concerns (Bovenberg and van der Ploeg, 1994). In addition, some European countries have already implemented such environmental tax reforms, where an introduction of various environmental taxes (carbon dioxide or sulphur dioxide) is compensated by a reduction in personal income taxes or social security contributions (Bosquet, 2000). The motivation for such a policy would be valid for Russia, too, since the level of unemployment in Russia accounted for 7.5% of the total labour force in 2010 (FSSS, 2012). Moreover, distortions from labour taxation may be substantial in Russia: both taxes on labour income and social security contributions accounted for 27% of total government revenues in 2010 (FSSS, 2011a). Furthermore, substituting carbon taxes for labour taxes explicitly addresses the issue of income inequality, which is of high relevance for Russia. For example, the Gini coefficient for Russia was 0.42 in 2009 (FSSS, 2011b).

Apart from tax distortions on factor and commodity markets, another important aspect which is often neglected in empirical studies is non-tax distortions from imperfect competition. In any real economy, many markets can be characterized as being imperfectly competitive. For example, many resource-based sectors require high investments in plants and equipment and therefore exhibit decreasing average costs (Devarajan and Rodrik, 1991). According to analytical work on this issue, market structure can significantly affect the outcome of an environmental tax reform. We therefore consider imperfect competition in some output markets in our analysis.

In this analysis, we introduce carbon taxes refunded through a reduction in taxes on labour income to address the following objectives: (i) to test the double dividend hypothesis under perfect and imperfect competition in output markets, to analyse (ii) the incidence of carbon taxes, (iii) impacts on sectoral competitiveness, and (iv) effects on income equity. The analysis is based on a computable comparative static general equilibrium model—an energy/environment adaptation of the STAGE model (McDonald, 2007). To our knowledge this is the first such study for Russia, addressing the issue of a double dividend under perfect and imperfect competition. Moreover, despite comprehensive analytical work on environmental taxation under imperfect competition, there are few studies which treat this issue in complex numerical CGE models, which are able to reflect real-world complexities (e.g. Böhringer et al., 2008).

The paper is organised as follows. Section 2 gives a brief overview on the literature on environmental taxation under imperfect competition, accompanied by some analytical results. Section 3 provides a brief description of the model framework, database, and experiments—a formal and informal description of the model can be found in the appendix Supplementary material. The results of simulations are presented in Section 4. Section 5 summarises the main results together with suggestions on how the analysis can be further developed.

2. Environmental taxation under imperfect competition

2.1. Literature

One of the central questions raised in the environmental taxation literature is whether the second best optimal environmental tax rate is higher or lower than the Pigouvian one in the presence of pre-existing distortions. In a first best world, the optimal environmental tax rate equals the marginal social damage, i.e. the so-called Pigouvian tax (Carlsson, 2000). Under a second best setting, the design of environmental tax policy can be much more complicated. The most important findings from the previous literature are the following:

1) Bovenberg and Goulder (1996) show that in the presence of distortionary taxes in the labour market, the optimal environmental tax rate is generally below the Pigouvian tax rate. Intuitively, substituting narrow-based taxes (environmental taxes) for broad-based taxes (labour taxes) tends to exacerbate pre-existing distortions of the tax system.
2) If polluters are imperfectly competitive, there can be a trade-off between the two distortions, one due to suboptimal production (underproduction), and the other due to negative externalities. A pollution tax can reduce external damages, but it can also lead to a reduction of an already suboptimal production level (Buchanan, 1969). Barnett (1980) and Misiolek (1980) formally show that the second best optimal environmental tax rate for monopolistic polluters is typically less than marginal social damage. Ebert (1992) draws the same conclusion for the case of oligopolistic polluters. Generally, under the assumption of symmetric firms and blocked entry/exit, the second best optimal tax rate falls short of the marginal social damage.