Simultaneous market power for complementary goods: the case of gas and emission permit exports from the Former Soviet Union countries.

By

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Abstract

With implementation of the Kyoto Protocol, the Former Soviet Union (FSU) countries are likely to be in a position where they can exert market power in both the emerging emission permits market, and in the gas market. Because actions in permit market affect prices and profitability in the gas market, and vice versa, it is possible that the FSU will choose to coordinate the exertion of gas and permit market power. We employ a general equilibrium model to explore the impact of market power both in a situation where gas producers and permit sellers act independently, and in a situation where they coordinate their actions. We find that although the total gain from coordination turns out to be small, the gas export is significantly higher with coordination of market power policy. The permit export and international permit price is less affected by a coordination of market power policies.

Introduction

The Kyoto Protocol requires that the average annual emissions of a basket of six greenhouse gases in the industrialized countries do not exceed 95 per cent of 1990 emissions in the period 2008-2012[2]. We will assume that the Protocol is implemented, and implemented as originally intended. The Kyoto Protocol allows for emission permit trading among the Annex B countries. Some countries may become large traders and thus be in a position to exercise market power in the permit market. As pointed out by Hahn (1984), the degree of market power in the permit market depends on the initial allocation of permits. The literature on the economic impact of the Kyoto Protocol suggests that Russia and other Eastern European countries will become large exporters of permits (see Weyant and Hill (1999) and Weyant (1999)). It is quite likely that the FSU countries will

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2 USA and Australia have chosen not to ratify the Protocol, and the entering into force of the Protocol hinges on Russian ratification. The agreement will not enter into force, until it has been ratified by at least 55 countries which together contribute to at least 55 percent of the industrialized world's greenhouse gas emissions in 1990.

be able to exercise some market power in the emission permits market. A recent quantitative analysis by Böhringer (2002) concludes that the FSU can significantly increase its benefit of the agreement by restricting its supply of permits.

The Russian Federation is a major player in the European gas market. Russia enjoys a market share of 42% in the European gas market (IEA (2001). There is every reason to believe that Russia can, and indeed is exercising market power in the gas market.

Russia (or rather the FSU) can thus be expected to be able to exercise market power in both the gas market and the emission permits market. This provides us with an interesting case for exploring simultaneous market power in two, strongly interacting, markets.

Because the two markets interact, it might be profitable to coordinate the exertion of market power in these two markets. Moe and Tangen (2000) pointed out that it is not unreasonable that the Russian authorities will allocate a substantial share of the country's emission permits to various commercial agents. They also argue that the dominating Russian gas producer, Gazprom, may be left in control of a large share of Russia's permits. In this case, the supply of permits may be coordinated with the supply of gas in order to maximize the total economic rent.

A theoretical model exploring coordination of market power was developed in Hagem and Mæstad (2002). The purpose of this paper is to carry out numerical analyses based on that model.

It is not obvious that a fossil fuel exporting country, such as Russia, will benefit from exercising its market power in the permit market: Exercising market power in the permit market will increase the permit price. A high price on emission permits, however, may reduce the demand for fossil fuels.

The presence of market power on the producer side of the fossil fuel markets adds an extra dimension to the analysis of simultaneous market power. The gas producers in Russia may be able to influence the price of emission permits through their production decisions. In other words, gas producers may have market power in the permit market as well. This requires, of course, that the combustion of fuels in the gas market constitutes a significant part of the total emissions by the countries participating in the emissions trading. Russia may therefore be able to influence the price of emission permits not only directly through the supply of permits, but also indirectly through its role as a large gas producer.

Hagem and Mæstad (2002) calculate, based on projections by the International Energy Agency, that the combustion of gas in the European gas market will cause around 20% of total greenhouse gas emissions in all industrialised countries in 2010 (excluding the USA). The corresponding figure for the global oil market is 33% (IEA, 2000). Hence, it is not unlikely that Russian gas and oil producers may be able to exercise some market power also in the permit market.

In the next section we will present a theoretical model that builds heavily on Hagem and Mæstad (2002). While other models takes into account that the permit market equilibrium affects the gas market (for example Böhringer 2002), this model also allows for the opposite effect – the influence of the gas market upon the permit market. The model shows that coordination may have important implications for the equilibrium price of emission permits. However, these results are ambiguous, and the actual outcome depends on whether increased gas supply increases or decreases the permit price, and whether increased permit supply increases or decreases the gas price. Then, in the following section, we will introduce the applied general equilibrium model that we will use for the numerical evaluation of these questions.

In the *results* section, we will focus on two main research questions:

1. What are the effects of having simultaneous market power in two markets, on each of the markets, or in other words, what are the economics of simultaneous market power.
2. What are the consequences of coordination of market of power for the gas and permit market.

Finally, we draw our conclusions. We find that although the total gain from coordination turns out to be small, the gas export is significantly higher with coordination of market power policy. The permit export and international permit price is less affected by a coordination of market power policies.

A simplified theoretical model[3]

The main purpose of this paper is to explore numerically the impact of coordinated and uncoordinated market power in the gas and permit market. In order to elaborate the driving forces behind the results from the numerical model, we find it useful to present a simplified theoretical model for market power in the gas and permit market. In the theoretical model presented in this section we model the gas market as a monopoly with Russia as the monopolist with zero marginal cost of gas production. Furthermore we include only one alternative primary energy source, and there is only one country (Russia) that can influence the permit price directly through permit trade[4].

Russian gas production is denoted x^R_g . The inverse gas demand function is given by

$$p_g = p_g(x_g, x_a) \tag{1}$$

where x_g is gas consumption and x_a is the consumption of alternative fuels, and with the assumed properties $\partial p_g/\partial x_g < 0$ and $\partial p_g/\partial x_a \leq 0$.

The inverse demand function of the alternative fuel is

$$p_a = p_a(x_a, x_g) \tag{2}$$

with $\partial p_a/\partial x_a < 0$ and $\partial p_a/\partial x_g \leq 0$

The consumption of one unit of gas causes e_g units of greenhouse gas emissions, while the emission factor of the alternative fuel is e_a. An international environmental agreement à la the Kyoto Protocol defines upper bounds on the emissions of greenhouse gases in each of the participating countries. We assume that emission permits are traded internationally at the permit price q. A positive permit price implies a downward shift in

[3] The model presented here is based on the model presented in the paper by Hagem and Maestad (2002) containing a theoretical discussion of the issues raised in this paper.

[4] In our numerical model we include other sellers of gas as a competitive fringe. Marginal gas production costs are positive. Furthermore, we include the major fossil fuels (gas, coal and oil).

the inverse demand function of fuels. Producers are then faced with the following effective inverse demand functions

$$p_i(x_i, x_j) - e_i q, \qquad \text{i, j} = \text{a, g}, \quad \text{i} \neq \text{j} \tag{3}$$

The market for the alternative fuel is assumed to be perfectly competitive. The equilibrium quantity is then found where the "producer price" given by (3) equals the marginal costs of production. We characterize the equilibrium in the market for the alternative fuel in a reduced form as follows

$$x_a = x_a(x_g, q) \tag{4}$$

The equilibrium quantity of the alternative fuel x_a will decline with the gas volume x_g because the fuels are substitutes ($\partial x_a/\partial x_g \leq 0$). A higher permit price will also reduce the quantity of the alternative fuel (for a given level of x_g) as long as the emission factor e_a is positive ($\partial x_a/\partial q \leq 0$).

In the gas market, the equilibrium condition is given by

$$x_g^R = x_g \tag{5}$$

The profit of the gas producer, π_g^R, can now be defined as a function of the gas production quantities and the price of emission permits

$$\pi_g^R(x_g^R, q) = (p_g(x_{g,}x_a) - e_g q)x_g^R = p_g(x_g^R, x_a(x_g^R, q)) - e_g q)x_g^R \tag{6}$$

Profit maximizing behavior will determine the equilibrium gas quantities as a function of the permit price ($x_g^R = x_g^R(q)$).

The price of emission permits q is determined by supply and demand in the permit market. The demand for emission permits faced by the Russian permit exporter can be divided into two components. First, there is permit demand generated by gas consumption and consumption of the alternative fuel (i.e., $e_a x_a + e_g x_g$). Second, there is the residual permit demand from all other emission sources in the participating countries, represented by the demand function d(q). The residual permit demand is assumed to decline with the price of permits ($d_q < 0$). The net demand for emission permits faced by the Russian permit exporter is then $e_a x_a + e_g x_g + d(q) - Q$, where Q is the total emission quota allocated to the participating countries (except Russia).

Let y denote Russian export of emission permits. The Russian profit from permit exports, π_p^R, is then

$$\pi_p^R(y) = qy - c(y) \tag{7}$$

where c(y) represents the costs of generating y units of permits for export. The shape of the cost function is determined by the initial allocation of permits to Russia, and by the domestic abatement costs. Due to a high initial allocation of permits to Russia in the Kyoto Protocol, Russia may be able to export a certain amount of permits at zero costs. Exports beyond this amount will require domestic abatement.

The equilibrium condition in the market for emission permits can now be defined as

$$e_a x_a(x_g^R, q) + e_g x_g^R + d(q) - Q = y \qquad (8)$$

Eq. (8) defines the equilibrium permit price as a function of the total gas consumption and the Russian supply of emission permits, $q = q(x_g^R, y)$.

From the market equilibrium condition (eq.(8)) we find that the equilibrium permit price is a decreasing function of permit supply, that is $\partial q/\partial y < 0$. The sign of $\partial q/\partial x_g^R$ is however ambiguous[5].

Without coordination of gas and permit market policies in Russia, the optimal Russian supply of emission permits is found by maximization of π_p^R with respect to y, (see Eq. (7)) and the optimal Russian gas sales are found by maximization of π_g^R with respect to x_g^R (see Eq. (6)) Coordination implies that both the gas seller and the permit seller in Russia take into account the impacts on each others' profits. In effect, this implies that both agents maximize the total profit for Russia, π^R, given as

$$\pi^R = \pi_p^R + \pi_g^R \qquad (9)$$

In the numerical model we run three principal scenarios. In the first scenario, which is the reference scenario, there is perfect competition in the permit market, and monopoly power is exercised in the gas market. In the second scenario Russia[6] has monopoly power in both the permit and the gas markets; however they do not coordinate their market power. Finally, in the last scenario we analyse a situation where market power is coordinated across the gas and permit market.

Perfect competition in the permit market and Russia exercising monopoly power in the gas market, results in the following first order conditions:

$$\frac{\partial \pi_p^R}{\partial y} = q - c' = 0 \qquad (10)$$

$$\frac{\partial \pi_g^R}{\partial x_g^R} = p_g - e_g q + \left(\frac{\partial p_g}{\partial x_g} + \frac{\partial p_g}{\partial x_a}\frac{\partial x_a}{\partial x_g^R}\right)x_g^R = 0 \qquad (11)$$

Equation (10) states that with perfect competition in the permit market, the permit price equals marginal abatement costs,. Equation (11) is simply the standard monopoly condition including the cross-price effect through substitution with alternative energy sources.

With market power in both the permit market and the gas market, and where the markets are uncoordinated, the first order conditions are:

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[5] See Hagem and Mæstad (2002) for a more thorough discussion of the price derivatives.

[6] represented by Former Soviet Union in the numerical model

$$\frac{\partial \pi_p^R}{\partial y} = q - c' + \frac{\partial q}{\partial y} y = 0 \tag{12}$$

$$\frac{\partial \pi_g^R}{\partial x_g^R} = p_g - e_g q + \left(\frac{\partial p_g}{\partial x_g} + \frac{\partial p_g}{\partial x_a} \frac{\partial x_a}{\partial x_g^R} \right) x_g^R + \frac{\partial q}{\partial x_g^R} \left(-e_g + \frac{\partial p_g}{\partial x_a} \frac{\partial x_a}{\partial q} \right) x_g^R = 0 \tag{13}$$

Equation (12) shows that the optimal permit export is now given by the standard formula for a monopolist supply, where marginal revenue from permit export equals marginal abatement costs. For a given level of gas sales, the level of permit export is reduced in order to raise the permit price and extract the monopoly rents. However, the effect on the gas market equilibrium of market power in the permit market is more ambiguous. The presence of market power in the permit market is captured by the last term on the left hand side in equation (13). The expression within the brackets, $\left(-e_g + \frac{\partial p_g}{\partial x_a} \frac{\partial x_a}{\partial q} \right)$, represents the effect of increased price of emission permits on the producer price of gas. The term $-e_g$ reflects the direct, negative impact of higher permit price on the producer price of gas. The other term, $\frac{\partial p_g}{\partial x_a} \frac{\partial x_a}{\partial q}$, is an indirect, positive effect on the producer price of gas via substitution towards gas as the price of permits increases for the alternative fuel. It turns out that the net effect of these terms are ambiguous. Hence, we cannot on theoretical grounds determine whether higher gas productions leads to a higher or lower permit price, neither can we determine whether a higher permit price leads to a positive or negative shift in the producer price for gas.

Under the coordinated scenario where market power in the gas and the permit markets is coordinated, the first order conditions are as follows:

$$\frac{\partial \pi^R}{\partial y} = q - c' + \frac{\partial q}{\partial y} y + \frac{\partial q}{\partial y} \left(-e_g x_g^R + \frac{\partial p_g}{\partial x_a} \frac{\partial x_a}{\partial q} x_g^R \right) = 0 \tag{14}$$

$$\frac{\partial \pi^R}{\partial x_g^R} = p_g - e_g q + \left(\frac{\partial p_g}{\partial x_g} + \frac{\partial p_g}{\partial x_a} \frac{\partial x_a}{\partial x_g^R} \right) x_g^R + \frac{\partial q}{\partial x_g^R} \left(-e_g + \frac{\partial p_g}{\partial x_a} \frac{\partial x_a}{\partial q} \right) x_g^R + \frac{\partial q}{\partial x_g^R} y = 0 \tag{15}$$

By comparing equations (12) and (13) with equations (14) and (15), we can see that coordination now implies a different set of first order conditions for the Russian gas and permit exporters. The new term in equation (14) reflects the marginal effect of permit exports *y* on gas profits, while the new term in equation (15) refers to the marginal effect on gas exports on permit export revenues. However, since the sign of these additional terms are ambiguous, the implications of coordinating market power are uncertain. Therefore, in the numerical simulations in this paper we explore these results further.

The applied general equilibrium model

The theoretical analysis of simultaneous market power in the gas and permit market, has ambiguous implications, and so we will employ a computable general equilibrium (CGE) model to try to resolve this ambiguity.

The model is based on the GTAP-EG model (Rutherford and Paltsev 2000), which is a static multi-regional model. The data-input to this model is the GTAP-EG dataset, which is a reconciled database of the Global Trade Analysis Project (GTAPv5) database, and International Energy Agency (IEA) energy statistics. The GTAP database contains production and bilateral trade flow data for 1997. Unfortunately the database does not allow us to distinguish the countries of the Former Soviet Union from each other, so that while our interest lies primarily with Russia, we have to deal with the region as a whole in our model.

While the model contains data for 1997, we want to run scenarios for the Kyoto commitment period 2008-2012 (using 2010 as a representative year). The emission projections that we use were generated by the Oxford Model for Climate Policy Analysis (Bartsch and Müller 2000) and certain unpublished data from this model[7] (Aaheim 2000, personal communication). Because we use a static model, we need to assume that the structure of the economy does not change between 1997 (which we have data for) and 2010 (which we have emission projections for), and to scale the required 2010 emissions reductions to the 1997 emissions[8].

The model is an Arrow-Debreu general equilibrium model in Mathiesen format (Mathiesen 1985), and it is programmed in GAMS-MPSGE. There are two principal agents in the model - producers and representative agents (consumers).

Production is divided into fossil fuel, and non-fossil fuel production, which have different nesting structures. The output of the fossil fuel production is an aggregate of a resource input and a non-resource input. The non-resource input is a Leontief composite of labour and an Armington aggregation of domestic and imported intermediates. Non-fossil fuel production has a structure where the output is a Leontief composite of intermediate non-energy goods and a composite of energy and primary factors.

The representative agent is endowed with all the primary factors, and all income goes to the representative agent. This income is allocated between investment (represented by a savings good) and private demand. The private demand is represented by utility maximising behaviour, where utility is a constant elasticity aggregate of non-energy and energy consumption. Both intermediate demand and final demand are modelled through an Armington aggregation of domestic and imported goods. The Armington supply includes a transport margin which is proportional to the volume of trade.

We have kept the production trees, and all elasticities of substitution, as in the original model by Rutherford and Paltsev.

We have made extensions to the GTAP-EG model in two areas. The first is to introduce emissions trading, while the second set of extensions relate to market power.

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[7] Personal communication: Aaheim, A, 2002, Researcher CICERO.

[8] Because of this scaling we can not use the absolute numbers. The relative changes will be correct, given our assumptions, but the absolute numbers will be misleading. We will therefore report only relative changes.

We assume that the Kyoto protocol is implemented through an international emissions trading scheme, such that emissions of CO_2 from the production and use of fossil fuels requires emission permits[9]. In the model this is represented through a zero elasticity of substitution (Leontief technology) between the fossil fuel and the emission permit inputs to the production (intermediate and final energy demand). The amount of permits required for each unit of fossil fuel is determined through emission coefficients, which are implemented in the GTAP-EG model, and which are calibrated to actual emission in 1997.

Each region is given an endowment of tradable emission permits. The size of the endowment is equal to the Kyoto commitment of the region. The market is modelled as an international emission permits trading pool – where all regions initially sell their permits, before the sectors in each region purchase the permits that they need – at a world price.

In the model market power is exercised only in the export markets. The cost to the FSU of exporting permits lies in the domestic abatement costs. In the gas market our assumption of exercising market power only over exports is based on what seems to be the actual situation: FSU companies can buy gas at a lower price than the international price (however supplies are unstable).

The market power scenario we use in the model is a monopoly with a competitive fringe, where the FSU is the monopolist in both the gas and the permit market[10].

Results and discussion

We use the model to explore the two main questions; what does having simultaneous market power in two related markets entail, and what are the effects of coordination on the gas and permit markets.

The model was used to run three principal scenarios. In the first scenario ("competitive") there is a competitive permit market, while the FSU has market power in the international gas market. We use this scenario to investigate the effects of having simultaneous market power in two markets, which is the second scenario ("uncoordinated"); The FSU has market power in the international gas and permit market, and the gas and permit agent maximise their profits from exports of gas and permits, as independent agents. The gas exporter takes into account that gas exports affect the demand for permits, and hence the international permit price, which in turn affect the producer price of gas (as explained in the theory section). The third scenario ("coordinated") is used to explore the effects of coordination; gas and permit market power is coordinated through one joint agent who receives the markup profit from both international markets.

We will use the "competitive" scenario as a baseline throughout the paper. This means that we have normalised the results of this scenario; all prices (measured at marginal cost

[9] The only Kyoto Protocol gas that is included in the model is CO_2. Furthermore, no sinks are included, and emission reductions through the Clean Development Mechanism are also not included.

[10] We optimise by iterating through different price-quantity equilibria until we find the maximum profit. To try to preclude the possibility of finding only a local optimum, we start the iterations from both extremes of possible markups/prices in both markets.

– which is the producer price for domestic sales) and quantities are set equal to 1.000. The model assumes zero-profits in any competitive market. This means that the domestic gas price will be equal to the marginal cost of production, while the domestic permit price will be equal to the marginal abatement cost. In the case of export goods, the producer price will be equal to marginal cost plus the markup.

In addition to prices and quantities, the markup profit (not the revenue) from the gas market, is also set equal to 1.000[11]. In the rest of this paper, all results are reported as changes relative to this scenario. To make it easier to keep track of all the prices and quantities and the changes in them, we have summarised the results in table 1.

Because we normalize the results from this scenario, there are only a few further results to report; the gas agent chooses a 61% markup. The producer price on gas exports will therefore be 1.61. Gas exports from the FSU are then responsible for 16.7% of total gas consumption in Europe, excluding the FSU[12].

Permit exports are equal to 29.9% of the total FSU permit allocation. The FSU is then responsible for 64% of all international permit sales.

In the "uncoordinated" scenario, we introduce market power in the international permit market. This causes a set of adaptations. The optimal markup on permits is 300%. With a 300% markup the international permit price increases to 1.240 (remember that both the domestic and the international prices were 1.000 in the competitive scenario). Permit exports amount to 16.1% of the FSU quota. Because of the zero-profit condition, there were of course no profits from the permit market in the competitive scenario. Because we therefore do not have a basis for comparison, and because we need to be able to compare the size of the permit profits to the size of the gas profits, we will report the permit market profits relative to the gas market profits in the competitive scenario. The permit market profits are 2.758[13].

When the permit price changes, the demand for gas is affected. As we discussed in the section on the theoretical model, whether a higher permit price leads to a positive or a negative shift in the inverse demand function for gas is an empirical question. One possible outcome is that, since gas is less emission intensive than other fossil fuels, there is a positive effect on the producer price of gas through the substitution of other fossil fuels with gas. However, it turns out that in our model, on aggregate, the increased international permit price has a negative effect on the (export) demand for gas. As a response to the exogenous negative shift in the inverse demand function for gas, it is optimal for the gas producer to reduce the gas exports. In addition, before choosing a new export level, the gas producer will take into account the possibility to influence the permit market; Since a higher permit price leads to a decrease in the profits, the gas producer's possibility to influence the permit price (through the volume of gas sold), leads (ceteris paribus) to a decreased gas supply as that causes the permit price to fall (shown in test

[11] Zero-profits are assumed in all markets in the model, except where we model market power. There are therefore no profits from the permit market in this scenario.

[12] We have chosen to focus on exports to Europe only, because this is where 92% of FSU gas exports go, and it is in the European gas market that the FSU is assumed to have market power.

[13] Though the absolute numbers can be misleading, it might be useful to get some sense of the absolute size of the permit revenue; Permit revenues account for around 1.7% of GDP, and using the 1997 GDP for FSU, that would be about US$ 10 billion.

runs with the model). In the resulting equilibrium, total FSU gas exports have declined by 32.8%.

Since the permit exports have decreased, more permits are sold on the domestic market, and the domestic permit price falls to 0.310. This produces an increased domestic demand for gas (the exact increase is 14.1%). The overall outcome is that the demand for gas increases by 8.8%. Because the production expands we move up along the marginal cost curve, and the marginal cost of gas production increases to 1.112. In the new equilibrium the optimal markup on gas exports is 49%, and this gives a producer price on gas exports of 1.657. The gas agent receives profits of 0.846, and the combined profits from the two markets are then 3.604.

With the "coordinated" scenario we can explore the effects of a possible coordination of market power in the two markets. Since an increase in the international permit price decreases the profits from the gas exports (as reported above), and as an increase in the gas (export) supply leads to a higher international permit price (shown in test runs with the model), coordination of the market power implies a larger export of both permits and gas; the increased permit supply (which produces a lower international permit price), will increase the foreign demand for gas, and the increased supply of gas will increase the price received for the permits exported. The joint agent chooses to lower the markup on permits to 285%, and the markup on gas to 39%.

This results in a domestic permit price of 0.321, and an international price of 1.236. Moving from the uncoordinated to the coordinated scenario, permit exports increase by 2.5% (to make up 16.5% of the FSU quota). The profits from the permit exports increase to 2.776 (up 0.65%). The first move of the permit agent is to export more permits than would have been optimal if it was not for the coordination policy. The isolated effect of this increase in exports would be to decrease the profits from this market. However, because the gas agent also increases exports, and because increased gas exports leads to an increase in the permit price, the final outcome is an increase in the profits from the permit market.

While gas exports increase by a significant 16.7%, domestic gas sales decrease slightly (due to the increased domestic permit price). Still, the overall demand increases, and again we move up along the marginal cost curve: While the domestic gas producer price (marginal cost) increases to 1.118, while the export gas producer price, because of the reduced markup, decreases (compared to the uncoordinated scenario) to 1.554. Markup profits from the gas market are now 0.838. This is a decrease of 1% from the uncoordinated scenario.

The combined profits from the two markets are 3.614. This is an increase of 0.28% from the uncoordinated scenario. This is a small overall gain. However the small change in total profits hides some larger (but opposing) changes; First of all, the overall increase in profits is the result of a somewhat larger increase in profits from the permit market – which is partially offset by a smaller decrease in profits from the gas market. If you look at the volume of exports, the effects are even greater: Permit exports increase by 2.5%, and gas exports by a significant 16.7%.

These results reveal that the absolute and marginal profits from the permit market are greater that those from the gas market; Gas market profits are "sacrificed" in order to increase the permit market profits.

The theoretical model has shown us that the profitability of coordination of market power depends critically on two derivatives: permit sales with respect to the gas price, and gas sales with respect to the permit price. Model runs show us that while the gas price (marginal cost, or producer price for domestic sales) decreases with increased permit supply, the permit price increases with increased gas supply.

Table 1: Summary results from the three scenarios

Parameter	"Competitive"	"Uncoordinated"	"Coordinated"
Permit market			
Domestic price	1.000	0.310	0.321
Int'l price	1.000	1.240	1.236
Markup	0 %	300 %	285 %
Exports (of FSU quota)	29.9 %	16.1%	16.5%
Profits	0	2.758	2.776
Gas market			
Domestic price (=mc)	1.000	1.112	1.118
International price	1.61	1.657	1.554
Markup	61 %	49 %	39 %
Market share of exports	14.7 %	10.1 %	11.7 %
Profits	1.000	0.846	0.838
Total profits	1.000	3.604	3.614

Concluding remarks

In this study we have used a general equilibrium model to explore the effects of simultaneous market power, and of coordination of such market power. Looking at the introduction of market power in the initially competitive permit market, we have shown that the increased international permit price (which follows from the restriction of permit exports in the exertion of market power), has a negative effect on the (export) demand for gas. As a response to this exogenous negative shift in the inverse demand function for gas, it is optimal for the gas producer to reduce the gas exports. When we look at a coordination policy, we find that although the total gain from coordination turns out to be relatively small, the gas export is significantly higher with coordination of market power policy. The permit export and international permit price is less affected by a coordination of market power policies.

These results are, of course, specific to the scenarios that we have chosen. The emission projections have a very significant bearing on the extent of FSU market power – because they determine how many permits the FSU will be able to sell at a given price. Also the choice of model parameters, such as substitution elasticities and production trees, will affect the outcome.

There is scope for further work on theses issues. The gas market is modelled relatively unsophisticated in our general equilibrium model. When the FSU chooses whether or not to coordinate its market power policy, that choice might be affected by how coordination affects the country's strategic position in the gas market. It would therefore be of interest to explore a model where we have Cournot competition instead of a monopolist.

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