Is Gas Cartel's Profitable for Russia?
(A Case of European Gas Market)

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The problem of gas cartel formation is widely discussed in many countries, including Russia. Gas cartel can exist only within the world natural gas market, the latter being possible provided liquefied natural gas (LNG) becomes wide spread. Since for Russia, European gas market is of prime importance the paper analyses perspectives of gas cartel, relative to the European market. Equilibrium states of such a market have been found for the two cases – that of a competitive behavior of LNG exporters to Europe, and of gas cartel which includes Russia and LNG exporters. Conditions ensuring that Russia gets higher profit in case of participating in a gas cartel, rather than in case of competitive behavior of LNG exporters, have been obtained.

Key words: Gas OPEC, Russian-European Gas Market
JEL classification: D4, Q4

Introduction

In recent decades the role of natural gas in supplying the world with power (Fig.1) has substantially increased due to heavy economic growth in South East-Asian countries, including China and India, tightened caps on emission of gases causing greenhouse effect, continued stagnation of nuclear energy sector, significant growth of world oil prices.
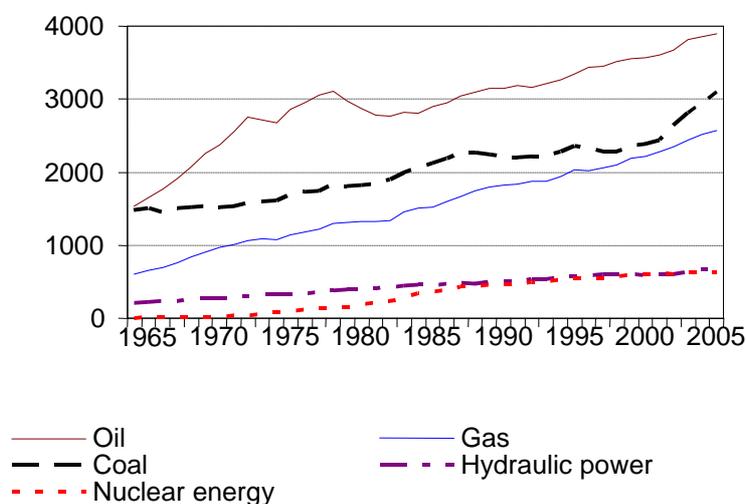

Fig. 1. Dynamics of primary energy resources global consumption, mln tons of oil equivalent

Source: BP Statistical Review. 2007

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In this environment the position of Russia as a country which accounts for 26% of global gas resources, ensures 21% of gas extraction and 20% of global export (BP (2007)) is getting even stronger. Imported Russian gas satisfies more than a quarter of European demand in this type of fuel, which provides Russia with a certain market power on the European natural gas market. Until now, though, there exists no world gas market (in contrast to oil), which is explained by rather high costs of natural gas transportation and their strong dependence on the haulage. Along with that the suppliers and consumers turn to be tightly linked to each other. That is why the prices for natural gas are determined by bilateral contracts between natural gas suppliers and consumers based on world prices for oil and oil products. On the European natural gas market there exist a number of threats to the Russian market power. One of such threats is an actual monopoly of Ukraine and Belarus in transit of Russian gas to Europe. One of the possible solutions to this problem is the construction of new gas pipelines to Europe (including the pipelines across the bottoms of Baltic and Black seas bypassing transit countries). Assessments show that the replacement of a transit monopoly with a duopoly reduces practically twofold the share of gas rent received by transit countries.

The second threat to the Russian market power is the liberalization of the European natural gas market. Thus, for example, the European Union has quite recently lifted the restrictions on resale of natural gas which deprived Gazprom of a possibility of pursuing price discrimination policy in the European natural gas market. In addition to that, caps are imposed on the lifetime of contracts for gas supplies to Europe.

And, finally, the third threat to the Russian market power on the European gas market is brought about by energetic growth of liquefied natural gas (LNG) production volumes. When cooled down to -160^0 C, natural gas is transformed into liquid state with a 600-times decrease of the occupied volume, which makes possible its transportation by methane carrier tankers to any distances. Along with that, both the suppliers and consumers receive broad opportunities in choosing their counterparties. Already now, despite relatively high costs of LNG production, in a number of cases the LNG is quite successfully competing with natural gas transported via pipelines and its share in the total global export of natural gas exceeds 28% (BP (2007)) and rapid growth of this share continues. It should be noted, that all together the "gas" policy pursued lately by Russia with respect to its neighbors and recently voiced threats of redirecting a substantial share of Russian gas export to Eastern markets, will, undoubtedly, lead to greater diversification of sources of gas supply to Europe. This may be achieved, first of all, with the help of Caspian countries and will stimulate the growth of LNG import which accounts now for approximately 10% of the total European import of natural gas. Since LNG may be transported to any distances,

in the absence of firm links between suppliers and consumers, wide expansion of LNG and increased density of pipelines may lead to the formation of a global natural gas market. The latter will undoubtedly weaken the market power of Russia in the European market. This should be taken into account when analyzing the efficiency of constructing new gas pipelines from Russia to Europe. On the other hand, the prospects of global natural gas market formation raise an important issue for Russia regarding the structure of this market. With account of a rather high concentration of global gas reserves in a relatively small number of countries, the prospects of establishing a gas cartel (similar to OPEC) seem to be quite realistic. The so called Gas Exporting Countries Forum (GECF) may serve as a prototype of a gas OPEC. The GESF was established in 2001 by ten countries[3] and unites now 51 largest gas-producing nations[4], which participate regularly in its annual meetings. These countries account for 73% of global reserves and 41% of the global extraction of gas (for comparison, OPEC accounts for 74% of the global oil reserves and for 41% of global oil production).

In the course of recent years the idea of a gas cartel has been widely discussed by economic and political circles as well as by the public in many countries including Russia. In this connection, one could cite a number of statements of political leaders of GECF member-countries on the possibility of a gas cartel establishment. Iran's spiritual leader Ayatollah Khamenei was the first political leader who officially announced the idea of a gas cartel. Algerian President A. Bouteflika stated, that "the gas OPEC should not be a priori excluded", and the Algerian Minister of Energy Sh. Khalil thinks, that "In the long-term perspective we are moving to a gas OPEC". Although the head of Russian Ministry of Industry and Energy V.Khristenko called "the gas OPEC" – "a fruit of broken loose imagination" and Deputy Chairman of Gazprom Management Board A. Medvedev stated that the establishment of a gas cartel similar to OPEC is impossible, the Russian President at the time (2007) V.Putin announced to western journalist in Qatar: " Who has told you that we have rejected the proposal on establishing a cartel? On the contrary. I have said that it is an interesting proposal". In this connection one could also cite a statement from the press-release on the results of Gazprom delegation's visit to Algeria in 2006: "… the Parties have considered possibilities of a joint implementation of "full cycle" projects, including the prospecting of hydrocarbons, their extraction, transportation, processing and **marketing** in Algeria, Russia and in **third** countries"[5].

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[3] Algeria, Brunei, Indonesia, Iran, Malaysia, Nigeria, Oman, Qatar, Russia, Turkmenistan.
[4] In addition to the above listed countries these are - Libya, Egypt, Trinidad and Tobago, Venezuela, Norway (an observer).
[5] Marked in bold by us.

It should be stressed that the existence of a "gas" cartel without Russia is hardly possible. Objectively speaking, the role of Russia in a "gas" cartel can be even more significant, than the role of Saudi Arabia (22% of world oil reserves and 13% of the world oil production) in OPEC. Although the "gas" cartel prospects are rather long-run, nevertheless, with the account of substantial inertia of the gas sector, as well as rather serious economic and geopolitical outcomes of the "gas" OPEC creation, it is reasonable to start taking this possibility into account already today.

Problems of natural gas supplies to Europe and problems of creating a "gas" cartel have been discussed in a number of papers (Yergin and Stoppard (2003), Revenkov and Feygin (2007), Cohen (2007); Finon, Locatelli (2008), Hallouche (2006), Morbee, Proost (2008), Perner, Seeliger (2003), Stern (2006)). Overwhelming majority of papers on the abovementioned topics are of conceptual nature and do not contain any assessments of possible outcomes of a "gas" cartel establishment for suppliers and consumers of gas. As regards the gas cartel proper, the papers discuss real prospects of its establishment. Thus, Finon and Locatelli (2008) have made a conclusion on the impossibility of a gas OPEC, in any case within the period of existence of long-term contracts for gas supplies. In his analysis of the GECF development, Hallouch (2006) argues the conclusion that this organization will automatically get transformed into a "gas" OPEC, although he does not exclude such a possibility for the future in a situation of excessive gas supply. Revenkov and Feygin (2007) propose even to exclude "…the very term of "gas" OPEC" from serious professional discussions. Other authors (Stern, (2006), Cohen (2007)) regard the prospects of a gas OPEC establishment as quite realistic. Papers by Perner, Seeliger (2004) and Morbee, Proost (2008) use formal economic models for the analysis of the problem considered. Perner and Seeliger (2004) use the EUGAS, a linear programming simulation dynamic model. Within the frame of this model the profit of cartelized gas suppliers to Europe is maximized at respective limitations on gas reserves, gas extraction and transportation capacity and etc. With that, the demand for gas is set as exogenous which substantially simplifies the model and disallows, in particular, market gas price assessments. Calculations based on the applied model have shown that a gas cartel establishment leads to a substantial growth of gas prices in Europe.

Morbee and Proost (2008) have analyzed the level of Europe's vulnerability from the perspective of Russian market power in the European gas market in a situation when Russia may breach its obligations of gas supply and Europe may create strategic gas reserves. They considered a duopoly model of gas exports to Europe (Russia and other exporters). The main conclusion of their research may be reduced to a statement that the Russian market power on the Euro-

pean market is limited since the demand for gas, even in the short-term perspective, is rather elastic. .

Despite a large interest to the idea of establishing a gas cartel, shown inside Russia, there are still no papers that would analyze its economic prospects for Russia based on formal models. This paper is devoted to such an analysis.

Since the European gas market, accounting for 100% of Russian gas export, is of special interest for Russia, the paper analyzes the prospects of gas cartel establishment from the European market perspective. It should be stressed again that the establishment of a gas cartel is only possible in the environment of an operating global gas market, which depends on a wide spread of LNG. For the purpose of simplifying the analysis a static problem is considered. The problem of coalitions' formation within the cartel is not discussed. Besides, there is no discussion of stability – one of the most important problems for any cartel.

1. Model

European natural gas market is characterized by the following linear reciprocal demand function:

$$P_E = a - b \cdot Q_E,\tag{1}$$

where Q_E - gas consumption in the European market, P_E - gas price, a and b - parameters.

It is assumed that there are 3 main suppliers of gas, operating in the European natural gas market: 1) European producers, 2) Russia and 3) other gas exporting countries[6], and, noteworthy, the latter supply natural gas in a liquefied form (LNG). For the three indicated groups the marginal costs of supplying gas to the European market equal c_E, c_R and c_L, respectively, whereas $c_R < c_E < c_L$.

It is assumed, that European gas suppliers behave competitively, which is in line with the energy policy of the European Union. With that, the volume of gas they supply to the European market equals $\overline{Q}_E = const$. There are no restrictions on LNG supplies to Europe. With the account of gigantic gas reserves in Russia, low (compared to other suppliers of gas to Europe) costs of transportation of Russian gas to Europe as well as significant capacity of pipelines going from Russia to Europe, it is assumed that Russia is a domineering player in the European gas market.

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[6] For example, in 2005, LNG was delivered to the European market by: Australia, Algeria, Egypt, Qatar, Libya, Malaysia, Nigeria, UAE, Oman and Trinidad and Tobago

Different variants of gas exporters' behavior in the European market are analyzed further below. The opening paragraphs 1.1-1.3 assume that no caps exist on the volume of Russian gas supplies to the European market.

1.1. Competitive behavior of LNG exporters

With account of significant volume of natural gas reserves and low cost of gas delivery to the European market (as compared to other suppliers), Russia may act as a monopolist in the European residual demand market. In Fig. 2 line aFA corresponds to the function of European demand for natural gas, line $BDFA$ - denotes the residual demand function for all the exporters of gas to the European market and line $KLDFA$ – the function of residual demand for Russian gas at competitive behavior of other countries-exporters of LNG.
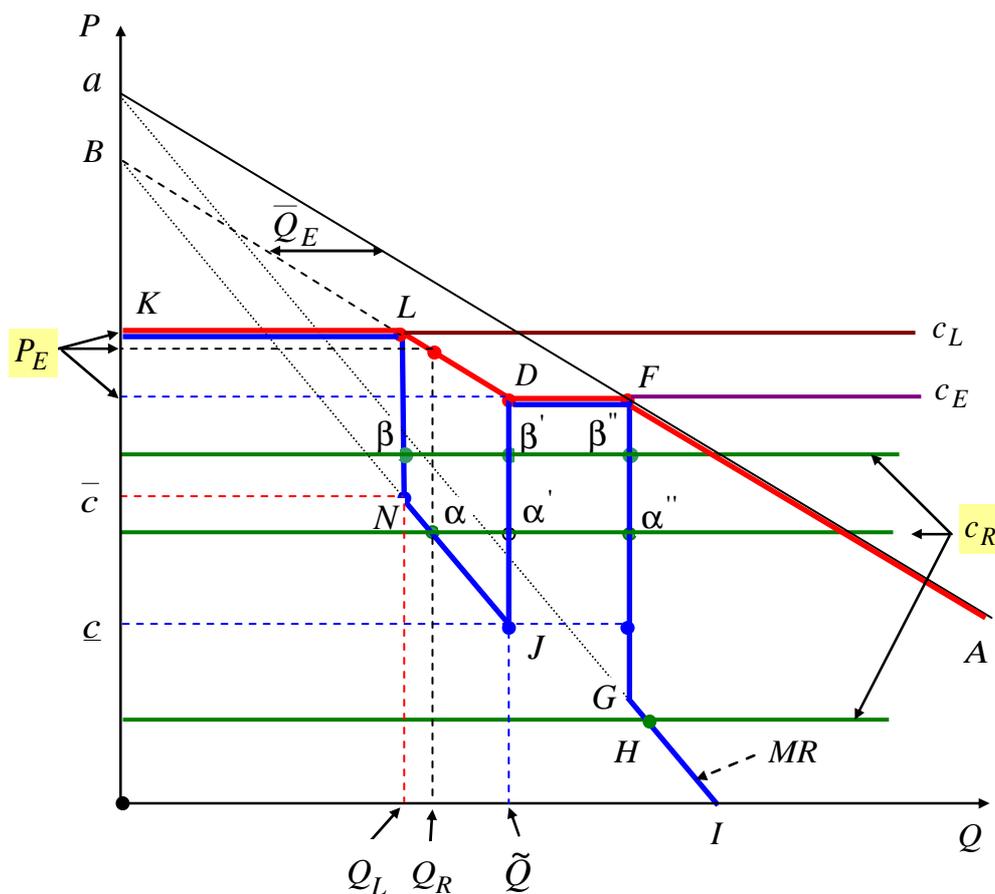

Fig. 2. **Equilibrium states of the European gas market at dominating role of Russia in the competitive environment**

Then line *KLNJDFGI* will correspond to the Russia's marginal revenue from supplying gas to the European market. In an environment when Russia occupies a monopoly position in the residual demand market the maximum of its revenue from supplying gas to Europe is reached in the point of marginal revenue equality to the marginal costs. Let us consider now the dependence of European gas market equilibrium states on the marginal costs of Russian gas supplies - c_R.

If $c_R < \underline{c}$, where $\underline{c} = 2 \cdot c_E - (a - b \cdot \overline{Q}_E)$, than, as it follows from Fig.2, there exists just one equilibrium point, corresponding to point H. With that, from the view point of European consumers' interests Russia could be the sole supplier of gas to the European market and the gas market price could be below the level of marginal costs of European producers. Nevertheless, in reality this scenario is hardly possible since Europe will not agree with complete ousting of its own producers from the market and will not accept Russia's absolute monopoly position in the European gas market. The natural reaction of European authorities in this case will be setting a minimum gas price on the level of marginal costs of European producers or introducing respective caps for the volume of Russian gas export. Then, the volume of Russian gas, supplied to the European market at a price of $P_E = c_E$, will be equal to

$$Q_R = \tilde{Q} = \frac{1}{b} \cdot (a - b \cdot \overline{Q}_E - c_E) \tag{2}$$

with that, Russia's profit will be equal to

$$\pi_R = \frac{(c_E - c_R)}{b} \cdot (a - b \cdot \overline{Q}_E - c_E). \tag{3}$$

If $\underline{c} < c_R < \overline{c}$, where $\overline{c} = 2 \cdot c_L - (a - b \cdot \overline{Q}_E)$, then, as is seen from Fig. 2, there are three equilibrium states, corresponding to points $\alpha, \alpha', \alpha''$, of which α, α'' are stable, and α' - unstable. Similarly to the above, we do not consider (as unrealistic) the case when the gas price in the European market turns to be below the marginal costs of gas supplied by European producers (an equilibrium corresponding to point α'') and, respectively, Russia becomes the monopolist in the European gas market. It is possible to demonstrate, that at $P_E \geq c_E$ the Russia's profit, corresponding to equilibrium point α, exceeds the profit, corresponding to equilibrium point α'', provided the following condition is fulfilled

$$(a - b \cdot \overline{Q}_E - c_R)^2 > 4 \cdot (c_E - c_R) \cdot (a - b \cdot \overline{Q}_E - c_E). \tag{4}$$

It is possible to show, that condition (4) is always fulfilled as a conditional inequality, i.e. the equilibrium, corresponding to point α, ensures maximum profit for Russia. In this case the gas price in the European market and the volume of gas supplied by Russia to Europe will be, respectively, equal to

$$P_E = \frac{1}{2} \cdot (a - b \cdot \overline{Q}_E + c_R),$$

(5)

$$Q_R = \frac{1}{2 \cdot b} \cdot (a - b \cdot \overline{Q}_E - c_R).$$

(6)

Russia's profit from exporting gas to Europe in this case will be equal to

$$\pi_R = \frac{(a - b \cdot \overline{Q}_E - c_R)^2}{4 \cdot b}.$$

(7)

If $c_R > \overline{c}$, out of the three possible equilibrium points, corresponding to points β, β', β'', the first one ensures maximum profits for Russia provided the following condition is met:

$$(a - b \cdot \overline{Q}_E - c_L) \cdot (c_L - c_R) > (a - b \cdot \overline{Q}_E - c_E) \cdot (c_E - c_R).$$

(8)

In this case Russia, as the sole exporter of gas to the European market will supply gas to Europe in a volume equal to

$$Q_R = Q_L = \frac{1}{b} \cdot (a - b \cdot \overline{Q}_E - c_L),$$

(9)

at a price $P_E = c_L$.

The profit of Russia in this case will be equal to

$$\pi_R = \frac{1}{b} \cdot (c_L - c_R) \cdot (a - b \cdot \overline{Q}_E - c_L).$$

(10)

1.2. LNG exporters' participation in the cartel

In the event there emerges a cartel which includes Russia and other exporters of gas to Europe, the residual demand for the cartel in the European gas market corresponds to line $BDFA$ (Fig. 3), and the marginal revenue of the cartel – to line $BJDFGI$.

Fig. 3. **Equilibrium states of the European gas market in a case when all exporters of gas to Europe are united into a cartel**

If $c_R \le \bar{c}$ (see Fig. 3), then the function of the Russia's marginal revenue in the respective range of P and Q values is in no way different from an analogous case of LNG exporters behavior in the European market considered in the previous section. It should be noted, that in this case the participation of Russia in the cartel brings it no added value.

Same way as in the previous section, stable equilibrium α ensures a higher profit for Russia versus equilibrium point α'', provided that condition (4) is met.

If $c_R > \bar{c}$ (see Fig. 3), then, from the perspective of interest of the cartel, as of a single economic agent, Russia should be the only participant of the cartel, supplying gas to the European market. With that, the gas price in the European market and the volume of Russian gas exported to this market are determined, respectively by expressions (5)-(6), and the cartel's profit will be equal to

$$\pi_C = \frac{(a - b \cdot \overline{Q}_E - c_R)^2}{4 \cdot b}.\qquad (11)$$

In this case, nevertheless, Russia will have to pay to other participants of the cartel a part of its additional (compared to the competitive case) profit for their agreement not to supply LNG to the European market. Assuming equal negotiation power of Russia on the one hand and of other participants of the cartel on the other, Russia will have to pay to other participants of the cartel a half of its additional profit (as compared to the above considered case of competitive behavior of LNG exporters). According to the solution by Nash, the profit of Russia in this case equals

$$\pi_R = \frac{1}{4 \cdot b} \cdot \left[\frac{(a - b \cdot \overline{Q}_E - c_R)^2}{2} + 2 \cdot (c_L - c_R) \cdot (a - b \cdot \overline{Q}_E - c_L) \right], \qquad (12)$$

Along with that the profit of all other participants of the cartel will equal

$$\pi_{OC} = \Delta\pi_R = \frac{1}{4 \cdot b} \cdot \left[\frac{(a - b \cdot \overline{Q}_E - c_R)^2}{2} - 2 \cdot (c_L - c_R) \cdot (a - b \cdot \overline{Q}_E - c_L) \right]. \qquad (13)$$

From comparing (10) and (12) it follows that the gain of Russia from participation in the cartel will amount to the profit of all other members of the cartel, excluding Russia, defined by expression (13).

In the case under consideration the participation in the cartel is beneficial for Russia if its profit, defined by expression (12), exceeds the profit defined by expression (10), i.e. in case the condition (14) is met

$$(a - b \cdot \overline{Q}_E - c_R)^2 > 4 \cdot (c_L - c_R) \cdot (a - b \cdot \overline{Q}_E - c_L). \qquad (14)$$

It is possible to demonstrate, that condition (14) is always met.

Generally speaking, with the account of the fact, that in exchange for the refusal of other cartel participants to supply gas to the European market, Russia may refuse to supply gas to other markets (North American, Asian), and Russia's profit may be substantially higher than the value defined by expression (12). Here it should be noted, that GECF participants are discussing a possibility of such agreements with respect to the European gas market in which the domineering position among the exporters belong to Russia and Algeria. For example, if Russia agrees to refrain from supplying gas to Spain, Algeria will be ready to refrain from supplying gas to Germany (Cohen (2007)).

Thus, in the case when Russia's marginal costs of extraction and transportation of gas to the European market are large enough (i.e. at $c_R > \overline{c}$), participation in the gas cartel may be beneficial for Russia..

1.3. LNG exporters participate in the cartel and supply their gas to Europe

Let us consider now the behavior of LNG suppliers exporting gas to Europe, which is characterized by their unreadiness to refrain from exporting gas to the European market in exchange of getting from Russia a part of its profit. In this case, to preserve the cartel's integrity it is necessary to establish quotas for gas exportation for all the cartel participants, including Russia.
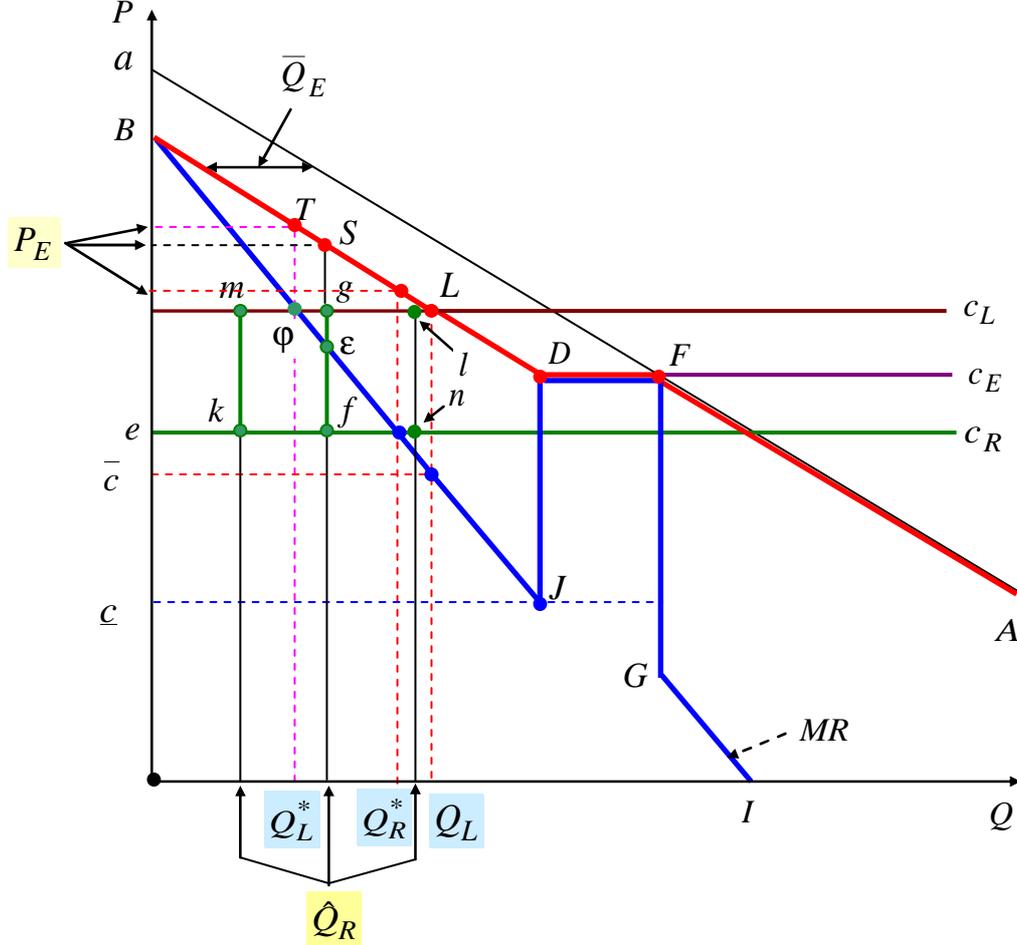

Fig. 4. **Equilibrium states of European gas market in the event of setting quotas for exportation of gas to Europe for all the cartel members, including Russia**

Let the Russian quota for exporting gas to Europe be equal to $\hat{Q}_R$. For the cartel to demonstrate its monopoly power in the European residual demand market in a situation when all the cartel participants are exporting their gas to Europe, it is necessary to ensure, that (see Fig.4) the Russian quota satisfies the condition

$$\hat{Q}_R < Q_L^* = \frac{a - b \cdot \overline{Q}_E - c_L}{2 \cdot b}. \tag{15}$$

With that the cartel marginal costs will correspond to line *ekmL*. In this case, maximization of the cartel's profit presumes, that the cartel will export to Europe an amount of gas equal to Q_L^*, at a price

$$P_E = \frac{a - b \cdot \overline{Q}_E + c_L}{2}. \quad (16)$$

Russia's profit in this case will equal

$$\pi_R = \left(\frac{a - b \cdot \overline{Q}_E + c_L}{2} - c_R \right) \cdot \hat{Q}_R. \quad (17)$$

Thus, in a situation when all the cartel participants export their gas to the European market, the participation in the cartel is beneficial for Russia if

$$\left(\frac{a - b \cdot \overline{Q}_E + c_L}{2} - c_R \right) \cdot \hat{Q}_R > \frac{(c_L - c_R) \cdot (a - b \cdot \overline{Q}_E - c_L)}{b}, \quad (18)$$

From which it follows that

$$\hat{Q}_R > \frac{(c_L - c_R) \cdot (a - b \cdot \overline{Q}_E - c_L)}{b \cdot \left(\frac{a - b \cdot \overline{Q}_E + c_L}{2} - c_R \right)}. \quad (19)$$

With account of (15) one may obtain from (19)

$$\hat{Q}_R > \frac{2 \cdot (c_L - c_R)}{\frac{a - b \cdot \overline{Q}_E + c_L}{2} - c_R} \cdot Q_L^*. \quad (20)$$

Consequently, to ensure the added value for Russia from participation in the cartel where all the participants export their gas to the European market, it is necessary for the share of Russia in the cartel gas export to the European market, ε_R, to satisfy the following condition

$$\varepsilon_R = \frac{\hat{Q}_R}{Q_L^*} > \varepsilon_R^*, \quad (21)$$

where the critical share of Russia in the cartel's export of gas to Europe equals

$$\varepsilon_R^* = \frac{4 \cdot (c_L - c_R)}{a - b \cdot \overline{Q}_E + c_L - 2 \cdot c_R}, \quad (22)$$

with that, the necessary condition for the cartel existence when all its participants export gas to the European market has the following form

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$$\frac{4 \cdot (c_L - c_R)}{a - b \cdot \overline{Q}_E + c_L - 2 \cdot c_R} < 1. \tag{23}$$

From (20), it follows in particular, that

$$\mathrm{sgn}(\partial \varepsilon_R^* / \partial c_R) = \mathrm{sgn}(c_L - a + b \cdot \overline{Q}_E). \tag{24}$$

It is easy to check that at realistic values of respective parameters $\partial \varepsilon_R^* / \partial c_R < 0$.

The dependence of the profit of Russia and of other cartel members on the Russian share in the cartel export of gas to Europe is presented in Fig.5.
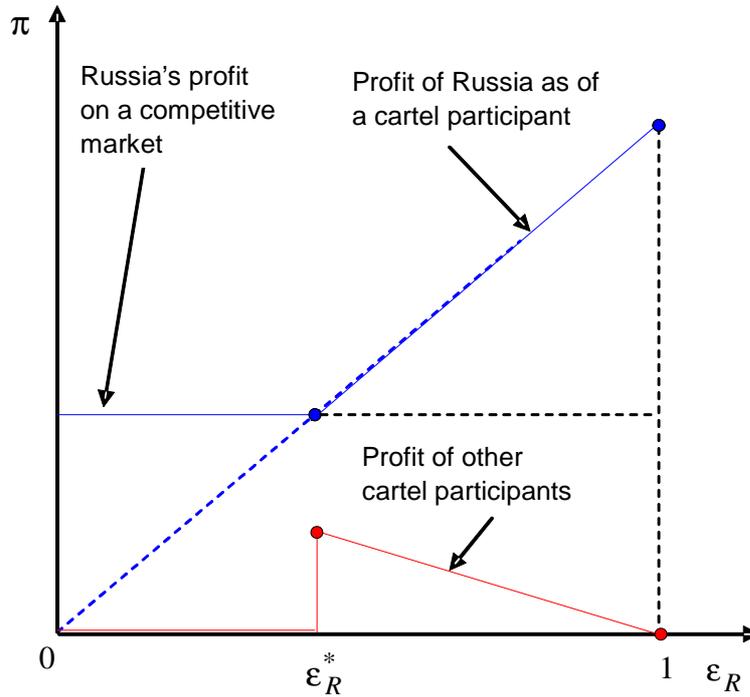

Fig. 5. **The dependence of the profit of Russia and of other cartel members on the Russian share in the cartel's gas export**

From Fig. 5 it follows, that at $\varepsilon_R < \varepsilon_R^*$ there is no added value for Russia from participation in the cartel and in this case it will be exporting all the gas necessary for Europe at a price equal to c_L, getting a profit defined by the expression (10).

1.4. Limited capacity for export of Russian gas to Europe

Until now it has been assumed that there are no limitations on Russian gas exportation to Europe. In practice, nevertheless, in the short-term and medium term perspective such export is

limited by the throughput of the existing gas pipelines. Let the maximum possible volume of gas export from Russia to Europe through pipelines equal $\overline{Q}_R$.

Firstly, we consider a case of $c_R < \overline{c}$, for which Fig. 6. presents gas market equilibrium states.
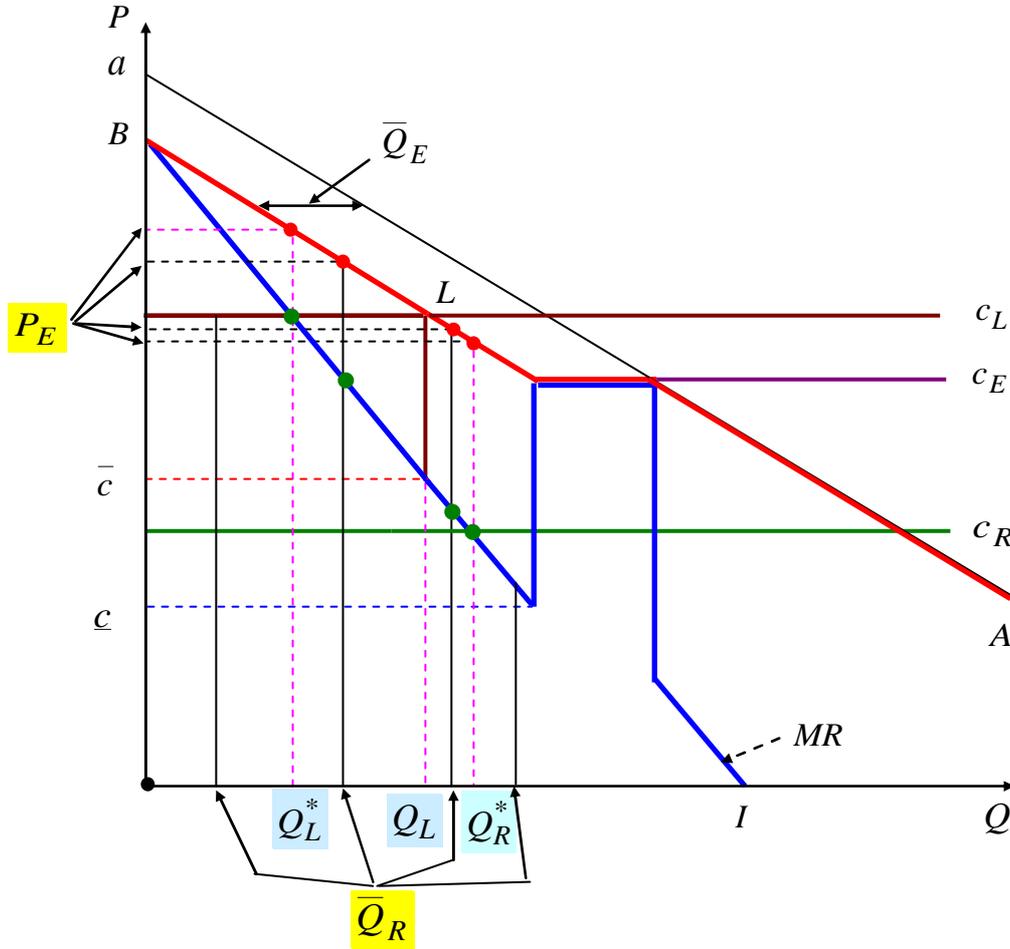

Fig. 6. **Equilibrium states of European gas market at limited export of Russian gas to Europe and at** $c_R < \overline{c}$

At $\overline{Q}_R < Q_L^*$, where Q_L^* is determined by (15), the cartel exports gas to the European market in an amount Q_L^* at a price P_E, determined by (16). In this case the cartel's profit equals

$$\pi_C = (c_L - c_R) \cdot \overline{Q}_R + (P_E - c_L) \cdot Q_L^*, \tag{25}$$

and the profit of Russia, at competitive behavior of LNG exporters -

$$\pi_R = (c_L - c_R) \cdot \overline{Q}_R. \tag{26}$$

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It is easy to notice that in the Nash equilibrium the profit of Russia, as a cartel participant, equals

$$\pi_R = (c_L - c_R) \cdot \overline{Q}_R + \frac{1}{2} \cdot (P_E - c_L) \cdot Q_L^*. \qquad (27)$$

Note, that from (27) it follows, that at $\overline{Q}_R = 0$ $\pi_R > 0$, which reflects the receipt by Russia of a premium from the cartel for joining the cartel. Of course, at $\overline{Q}_R < Q_L^*$ Russia is hardly able to act as a domineering company in the European gas market. Nevertheless, even in this case $(\overline{Q}_R < Q_L^*)$ the existence of the cartel has some added value for Russia, irrespective of its participation or non-participation in the cartel. Moreover, in this case it is more beneficial for Russia not to join the cartel, so as to be free of obligations on quotas.

At $Q_L^* < \overline{Q}_R < Q_L$, where Q_L is found from (9), the cartel will export to the European market an amount of gas $\overline{Q}_R$ at a price

$$P_E = a - b \cdot \overline{Q}_E - b \cdot \overline{Q}_R. \qquad (28)$$

The maximum of the cartel's profit is reached at the export of just Russian gas to Europe. If all the participants of the cartel agree with this the cartel's profit will equal

$$\pi_C = (P_E - c_R) \cdot \overline{Q}_R, \qquad (29)$$

And the profit of Russia, as a cartel participant, in line with the Nash solution equals

$$\pi_R = \frac{1}{2} \cdot (P_E + c_R - 2 \cdot c_R) \cdot \overline{Q}_R. \qquad (30)$$

It should be noted, that at competitive behavior of LNG exporters Russia's profit is defined by (26).

At $Q_L < \overline{Q}_R < Q_R^*$ (see Fig. 6) the cartel if of no added value for Russia. The maximum profit is received by Russia at its export of gas to the European market in an amount $\overline{Q}_R$ at a price, defined by (28). In this case Russia's profit equals

$$\pi_R = (P_E - c_R) \cdot \overline{Q}_R. \qquad (31)$$

The dependence of Russia's profit on $\overline{Q}_R$ for cases of competitive behavior of LNG exporters and of their participation in the cartel is presented in Fig. 7. If $\overline{Q}_R < Q_L$, than it is bene-

ficial for Russia to participate in the cartel, and if $\overline{Q}_R > Q_L$, than the participation in the cartel has no added value for Russia.

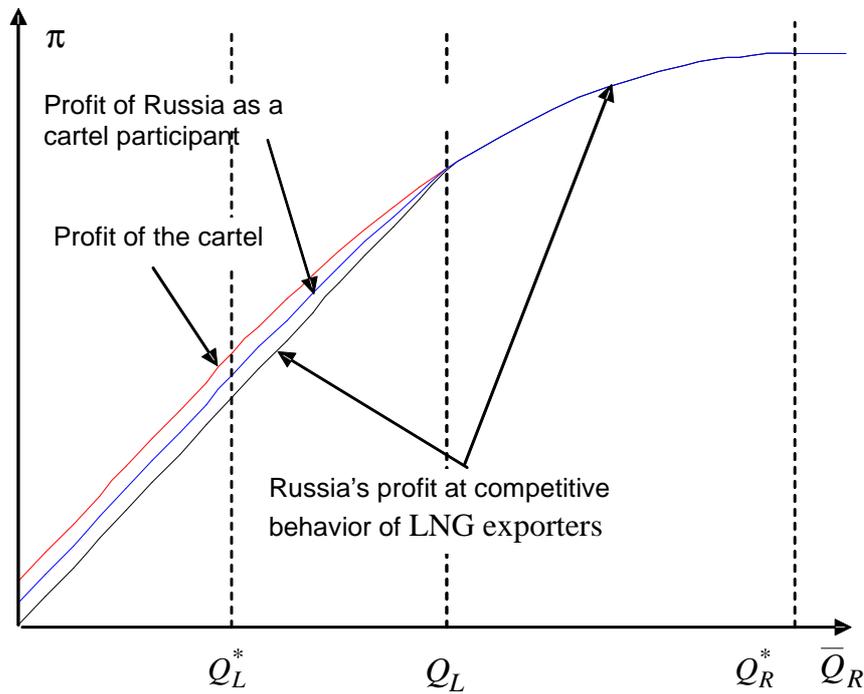**Fig. 7.** Impact of limitations on Russian gas export to Europe on Russia's and cartel's profit at $c_R < \overline{c}$

Equilibrium states of European gas market at $c_R > \overline{c}$ are presented in Fig. 8. From Fig.8 it follows, that at $\overline{Q}_R < Q_L^*$ the gas price in the market, the cartel's profit, the profit of Russia at competitive behavior of LNG exporters and its profit of a cartel participant are determined by the same ratios of (16), (25)-(27), as in the case of $c_R < \overline{c}$. With $Q_L^* < \overline{Q}_R < Q_R^*$ the gas price on the market is defined by (28), the cartel's profit – by (29), and Russia's profit at the competitive behavior of LNG exporters and as a cartel participant – by (26) and (30) respectively. At

$Q_R^* < \overline{Q}_R < Q_L$ the gas price in the European market is defined by (5), the cartel's profit - by the expression

$$\pi_C = (P_E - c_R) \cdot Q_R^*, \tag{32}$$

Russia's profit at the competitive behavior of gas exporters – by expression (26), and as of a cartel participant - by the expression

$$\pi_R = \frac{1}{2} \cdot ((P_E - c_R) \cdot Q_R^* + (c_L - c_R) \cdot \overline{Q}_R). \tag{33}$$

With $\overline{Q}_R > Q_L$ the price of gas in the European market is defined by (5), the cartel's profit – by (32). The dependence of the cartel's profit, Russia's profit at the competitive behavior of LNG exporters, as well as profits of Russia as of a cartel participant from $\overline{Q}_R$ will have a look presented in Fig. 9.
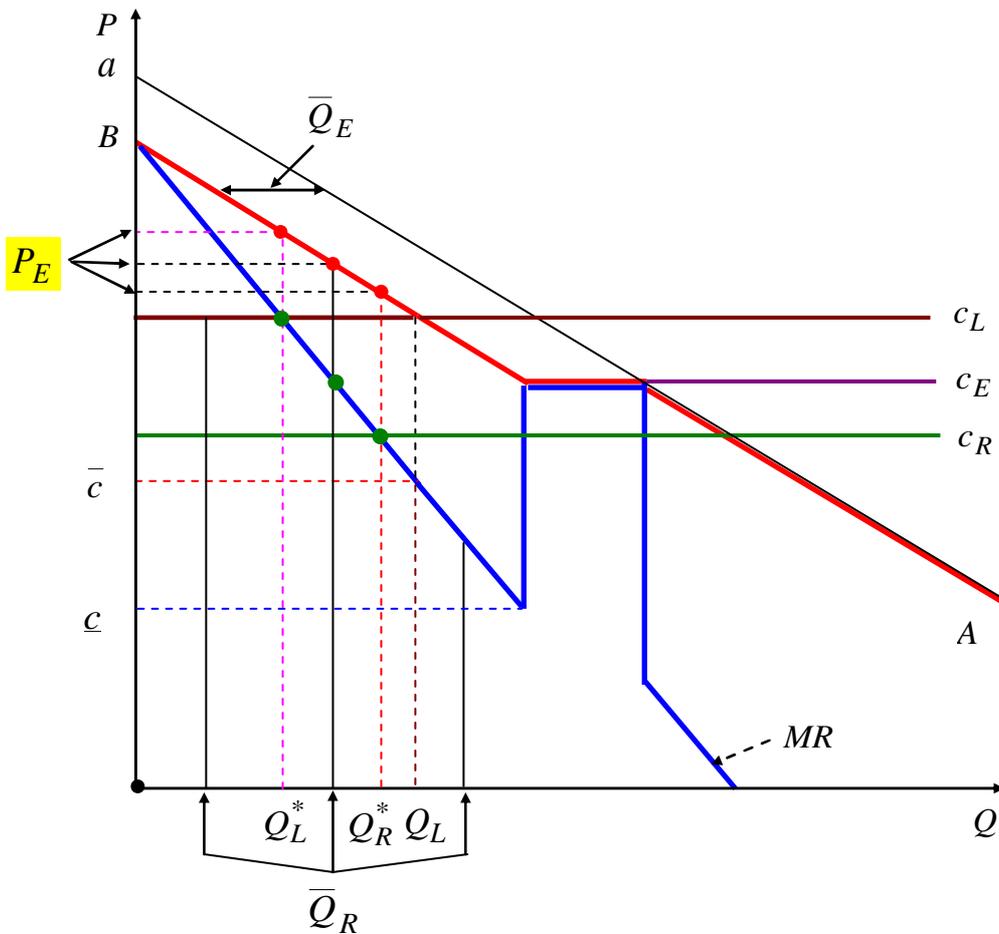

Fig. 8. **Equilibrium states of European gas market at limited export of Russian gas to Europe and at $c_R > \overline{c}$**

From Fig. 9 it follows that at $c_R > \bar{c}$ the gas cartel has an added value for Russia at any limitations on its gas export to Europe. It should be noted, that at $\bar{Q}_R > Q_R^*$ limitations on the export of Russian gas to Europe are non-binding.
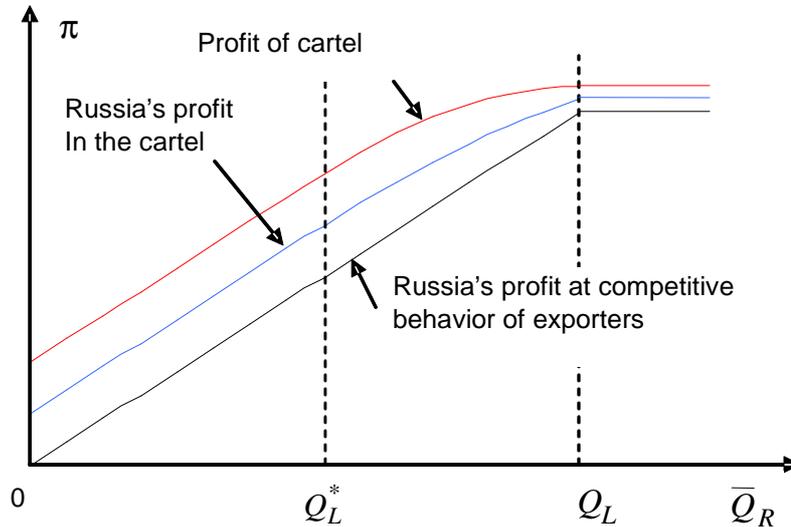

π

Profit of cartel

Russia's profit
In the cartel

Russia's profit at competitive
behavior of exporters

$0 \qquad Q_L^* \qquad Q_L \qquad \bar{Q}_R$

Fig. 9. **Impact of limited Russian gas export to Europe on the profits of Russia and of the cartel at $c_R > \bar{c}$**

2. Primary data

Long-term marginal costs of Russian gas exportation to Europe are, in fact, unknown. This is explained, on the one hand, by the fact that Gazprom remains, largely, a conglomerate the activities of which reach far beyond the framework of the gas industry, and, on the other hand, Gazprom, as a monopoly regulated by the Government, is not interested in publishing its real costs. And the government bodies regulating the gas tariffs in Russia do not publish the data on Gazprom costs on extraction and transportation of gas either. Absence of this primary information leads to a situation when the data on the costs of Russian gas production are comparatively rarely published and are sometimes contradictory.

Long-term marginal costs of Russian gas extraction and transportation through the territory of Russia are recognized to be equal to USD 8 /1000 m^3 and USD1.1/(1000 m^{3}x100 km) respectively (Tarr, Thomson (2003)), which at the transportation of gas to a distance of 3500 km to the border with Ukraine results in the assessment of long-term marginal costs of Russian gas export equal to USD 46.5/1000 m^3. Marginal costs of Russian gas transportation through the territory of Ukraine at a distance of 1100 km with a tariff of USD1.6/(1000 m^{3}x100 km) amount to USD 17.6/1000 m^3. At transportation from the Ukrainian Western border through Europe to the point

of sail of Russian gas (the calculated POS is Weidehaus in Germany) to a distance of 800 km and at a tariff of USD 1.7 /(100 m^{3}x100 km.) the Gazprom marginal costs are equal to USD 13.6 /1000 m^3. Thus, based on the above data, the long-term marginal costs of Russian gas transportation to Europe amount to USD 77.7 /1000 m^3.

It is assumed that the European natural gas market unites the consumers of 25 countries of Europe[7], it should be also mentioned that this market is fully integrated and has no limitations for gas transportation in Europe. When construing the demand function there were used the data on gas consumption in Europe for 2006 when it amounted to 491.1 bln m^3. It should be noted that the volume of gas supplied by European producers[8] was equal to 282.9 bln. m^3, the total volume of gas import to Europe, including LNG, amounted to 208.2 bln. m^3, and the average price for gas on the European market – to USD 313.1/1000 м^3 (BP (2007)). According to the cited data (OME (2001)), the long-term marginal costs of Norwegian gas extraction and transportation to Europe equal USD 79/1000 m^3. This value has been used in the calculations as the amount of long-term marginal costs of gas supplies from European gas fields.

In 2006 Russia exported to the mentioned 25 countries of Europe 127.3 bln m^3 of gas, where as Europe imported 57.4 bln m^3 of gas in the form of LNG from 7 countries: Algeria, Egypt, Qatar, Libya, Nigeria, Oman, Trinidad and Tobago (BP (2007)). Marginal costs of LNG exportation to the European market are taken equal to USD 130/1000 m^3 (Cornot-Gandolphe et. al. (2003)).

The available in literature assessment of short- and long-term elasticity of demand for natural gas in industrial countries ranges from -0.6 – -1.5 (Al-Sahlawi (1989), Beierlein et. al. (1981), Krichene (2002), Liu (1983), Taylor (1977)).

Table 1 presents the primary data used for construing an inverse function of demand for gas in Europe, as well as the values of marginal costs of gas supplies by European countries and exporters, which have been taken as constant in the calculations.

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[7] Austria, Belgium, Bulgaria, Great Britain, Hungary, Germany, Greece, Denmark, Ireland, Iceland, Spain, Italy, Lithuania, Luxemburg, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Finland, France, Czechia, Switzerland, Sweden.

[8] Great Britain, Denmark, Germany, Italy, the Netherlands, Norway, Poland, Romania.

Table 1

Primary data (2006)

Parameter	Value
Gas consumption in Europe, Q_{E0}, bln m^3/year	491.1
Gas production by European countries, $\overline{Q}_E$, bln m^3/year	282.9
Gas import to Europe, $\tilde{Q}$, bln m^3/year	208.2
Average gas price in the European market, P_{E0}, USD/ths m^3	313.1
Marginal costs of gas supply to the market by European producers, c_E, USD/ths m^3	79.0
Marginal costs of LNG supply to Europe, c_L, USD/ths m^3	130
Marginal costs of Russian gas supply to Europe, c_R, USD/ths m^3	77.7

3. Calculation results

As indicated above, the model uses a linear function of gas demand in Europe, while the price elasticity of demand η changes together with the volume of consumption. The parameters of the linear demand function have been calculated based on the assumption that the target function passes through the point (P_{E0}, Q_{E0}) (Table 1), and the price elasticity of demand in this point, due to a higher level of uncertainty, varies within a range from -0.6 to -1.5. Main parameters of the models used in the calculation are presented in Table 2.

Table 2

Values of the model main parameters

	Price elasticity of gas demand in Europe η in the point (P_{E0}, Q_{E0}),				
	-1.5	-1.2	-1.0	-0.8	-0.6
a (see (1)), USD/ths m^3	521.9	574.1	626.2	704.5	835.0
b (see (1)), USD * year/(mln m^3)^2	0.425	0.531	0.638	0.797	1.063
$\underline{c}$ (see Fig. 2), USD/ths m^3	-243.6	-265.8	-287.9	-321.1	-376.4
$\overline{c}$ (see Fig. 2), USD/ths m^3	-137.6	-159.8	-181.9	-215.1	-270.4
Q_L (see Fig. 2), bln m^3 / year	634	549	492	435	379
$\tilde{Q}$ (see Fig. 2), bln m^3 / year	759	649	575	502	429
Q_L^{*} (see Fig. 4), bln m^3 / year	317	275	246	218	189

From the fact that $\overline{c} < 0$, it follows, that the gas price in the European market may not be below the marginal costs of LNG export to Europe.

3.1. Competitive behavior of LNG exporters. Gas export from Russia is not limited

Table 3 presents the results of calculations for the case when LNG exporters behave competitively, in this case Russia may export to Europe any volume of gas. With the account of the fact that $\overline{c} < 0$, it follows from the analysis presented in section 1.1 that the gas price in the European market will be equal to the marginal costs of LNG export.

Table 3

Competitive behavior of LNG exporters. Russian gas export capacity is not limited.
$$P_E = c_L = 130 \text{ USD/1000 m}^3$$

	The price elasticity of demand for gas in Europe η at point(P_{E0}, Q_{E0})				
	-1.5	-1.2	-1.0	-0.8	-0.6
Volume of Russian gas export to Europe, bln m^3/year	634	549	492	435	379
Russia's profit, bln USD/year	35.1	30.4	27.2	24.1	21.0

It should be noted that the growth of the price elasticity absolute value leads to the growth of Russian gas export to Europe, and, accordingly, to the growth of profit for Russia. This is explained by the fact that all the demand functions, irrespective of their price elasticity of demand pass through one point corresponding to the status of European gas market in 2006. That is why for the linear demand functions used in the paper the growth of the absolute value of gas demand price elasticity in the indicated point at $c_L < P_{E0}$ leads to the growth of Q_E, and at $c_L > P_{E0}$ - to the reduction of Q_E.

3.2. LNG exporters participate in the cartel. The capacity of gas export from Russia is not limited

Table 4 presents the results of calculations for the case when Russia and countries that are LNG exporters, are united in a cartel but only Russia exports gas to Europe, paying a part of its profit to other cartel participants for refraining from exporting gas to the European market. As is evident from the comparison of data presented in Tables 3, 4, Russia's participation in the cartel ensures a growth of its profit as compared to the case of competitive behavior of LNG exporters.

Table 4

LNG exporters participate in the cartel and are ready to refrain from exporting LNG to Europe. The capacity of Russian gas export is not limited

	The price elasticity of demand for gas in Europe η at point(P_{E0},Q_{E0})				
	-1.5	-1.2	-1.0	-0.8	-0.6
Gas price in the European market, USD/ths m^3	239	250	261	278	306
Volume of Russian gas import to Europe , bln m^3/year	382	327	290	252	215
Russia's profit by Nash, bln USD/year	39.8	35.9	33.5	31.4	29.9
Profit of other cartel participants, bln USD/year	22.3	20.7	19.9	19.4	19.4

It should be noted that with the growth of the absolute value of European gas demand price elasticity, there increases the volume of Russian gas export to Europe and the profit of Russia, along with that the share of other cartel participants in the total cartel profit goes down.

3.3. LNG exporters participate in the cartel and supply their gas to Europe

Table 5 presents the calculation results for a case when LNG exporters - members of the cartel export gas to Europe and, accordingly, the cartel has to establish quotas for gas export to Europe for all its participants, including Russia.

Table 5

LNG exporters participate in the cartel together with Russia and export gas to Europe. The capacity of the Russian gas export is not limited

	The price elasticity of demand for gas in Europe η at point(P_{E0},Q_{E0})				
	-1.5	-1.2	-1.0	-0.8	-0.6
Volume of the cartel gas export, bln m^3/year	317	275	246	218	189
Gas price in the European market, P_E, USD/ths m^3	267	278	289	306	333
Critical quota of Russia in the cartel gas export, ε_R^*	0.6	0.6	0.5	0.5	0.4

It should be noted, that with the growth of the absolute value of the European gas demand price elasticity, the volume of gas exported by the cartel increases, the gas price goes down and the critical share of Russia in the cartel's gas export increases.

3.4 Limited throughput of gas pipelines from Russia to Europe

In all the variants of calculations presented in Tables 3-5, the volume of Russian gas export to Europe exceeds substantially the capacity of export gas pipelines, both existing and projected for the nearest future. This result demonstrates the necessity of analyzing the problem in question with account of limitations of gas pipelines from Russia to Europe.

Table 6 presents the results of calculating the profits of the cartel and Russia depending on the throughput of gas pipelines from Russia to Europe at the calculated price elasticity of demand $\eta = -1.2$.

Table 6

Dependence of the profits of Russia and of the cartel on the capacity of gas pipelines from Russia to Europe

	Capacity of gas pipelines for Russian gas export, bln m^3/year						
	150	170	190	210	230	250	270
Russia's profit in the competitive market environment, bln USD/year	8.3	9.4	10.5	11.6	12.7	13.8	14.9
Cartel's profit, bln USD/year	48.4	49.5	50.6	51.7	52.8	53.9	55.0
Russia's profit within the cartel, bln USD/year	28.3	29.4	30.5	31.7	32.8	33.9	35.0
The ratio of Russia's profit within the cartel to the profit at competitive behavior of LNG exporters	3.4	3.1	2.9	2.7	2.6	2.4	2.3

It follows from Table 6 that the volume of Russia's profit if it joins the cartel, increases together with the growing capacity of export gas pipelines from Russia to Europe. But for Russia the added value from participation in the cartel compared to the case of competitive behavior of LNG exporters turns to be a reverse function of the throughput of export gas pipelines from Russia to Europe.

Bearing in mind the assumptions made in the paper, as well as a large uncertainty of primary data, the results obtained are, to a certain extent, of an illustrative nature. Nevertheless, they

provide a quite adequate picture of terms under which the participation of Russia in the gas cartel may be economically justified. It should be noted, that at present the price of Russian gas, exported to the European market ,is determined by the price of an oil-products basket, that is why high international oil prices diminish substantially the stimuli for Russia's participation in the gas cartel. Nevertheless, along with liberalization of the European gas market, as well as in the event of a substantial reduction of international oil prices, the idea of organizing a gas cartel may become more economically attractive.

Prospects of a gas cartel establishment may have a serious impact on the policy of Russia in the gas sector. In the absence of a gas cartel Russia will have to substantially diversify the directions of gas export so as not to find itself standing in front of united Europe, playing the role of a monopsonist with respect to Russia. To ensure this, it is necessary to build new pipelines to Asia, as well as natural gas liquefaction plants which will require rather large investments. In the case of establishing a gas cartel with participation of Russia, this necessity goes down since the cartel participants may distribute different gas markets (European, North American and Asian) among themselves. From this perspective the possibility of a gas cartel establishment becomes even more attractive for Russia.

Conclusions

- Although the establishment of a gas cartel is a rather distant perspective, bearing in mind the substantial inertia of the gas sector as well as significant economic and geopolitical outcomes for the world in general and also for Russia, especially resulting from the cartel formation, such a scenario should be analyzed already now.

- At sufficiently high costs of Russian gas export to the European market the participation of Russia in the gas cartel may have an added value.

- Assessments show, that at quite realistic values of the main parameters the participation of Russia in the cartel ensures its higher profit compared to the case of competitive behavior LNG exporters.

- Limited throughput of export gas pipelines from Russia to Europe increases the attractiveness of participation in the gas cartel for Russia.

- Participation of Russia in the gas cartel will enable it to reduce the investments into construction of new gas pipelines to Asia and into LNG production.

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