International Gas Markets: Economics, Geography & Politics

Yuri Yegorov, Franz Wirl,
University of Vienna, BWZ

10th IAEE European Conference,
7-10.09.2009, Vienna, Austria (7-V)
Introduction.
Introduction.2

Gas is an interesting example in which the market structure cannot be derived from pure economic aspects. Due to huge required investments, substantial transport costs and large heterogeneity in gas deposits and major consumption areas geography is very important. Politics also plays an important role possibly constraining the economically optimal development.

Yegorov, Wirl IAEE 2009
Introduction.3

In particular, the following reasons are given for the peculiarities found in the natural gas market:

• Huge sunk costs and costly transportation;
• Uneven distribution of gas on Earth:
• Often bilateral relations, i.e., monopolistic-monopsonistic relationships;
• Transit countries may and do try to capture rents from the gas trade that can create an externality making a cost-ineffective investment preferable.
Literature.1


Literature survey. 1

• These works show the importance of interaction between economics, politics and geography in the case of gas in general. We can observe different market organization for natural gas in different parts of the world. On one hand, we have spatial (nodal) pricing of natural gas in Northern America that correctly reflects substantial infrastructure and delivery cost. On the other hand, we have the tendency to liberalize internal gas markets in the EU that seems to neglect spatial differences in delivery cost in favour of other arguments. Depletion of world gas resources makes delivery more costly and space more heterogeneous, and this naturally leads to growing local monopoly power of some gas producers. At the same time, development of LNG technology makes world markets more integrated and transforms this market from previously regional to more global. Under these conditions, it becomes clear that purely economic arguments about market structure and natural gas policy not always work. And it becomes increasingly important to develop interdisciplinary science that will take into account those complexities.
The works in regional science have shown that spatial (or geographical) factor can produce effects different from those of non-spatial economics. Thus, it represents an alternative self-organizing force. When we deal with gas markets, spatial distribution of consumers also plays a role similar to (Hotelling, 1929) model. However, we have also other effects. First of all, geography plays the crucial role in the selection of paths of pipelines or LNG ports. In abstract setting, one should solve an optimization problem of selecting optimal trajectories of pipelines in 2-dimensional space. Even apart from the issues of optimal capacity, associated risks and political constraints, we have a problem with spatial density of discovered gas deposits and density of consumption across the world, and a continuum of possible paths. Fortunately, many of the conceivable paths can be aggregated under one label, e.g., NABUCCO refers to many potential realizations with the common feature of connecting the Caspian region with Europe. Therefore, we can deal with a rather small set of generalized strategic pipelines, meaning by each pipeline not an exact project with fixed route and capacity, but a class of ideas. Therefore, economic theory must be complemented. We can conclude that for natural gas it is necessary to incorporate geopolitics and technology into formal economic model.
Necessity for new approach. 1

- Traditional economic theory considers consumers with preferences and producers with technologies. The reality of gas markets shows that this is not enough, because they have to be connected to the market. Connection (via pipelines or LNG) requires substantial investment that is comparable with the production cost. After connection to the market market participants find themselves in asymmetric conditions. This is not only asymmetric distance to the market that puts some more distant producers or consumers in less favourable position, but also a possibility for a third party to bring negative externality. The most typical example is the delay of pipeline construction between Turkmenistan and Pakistan due to political uncertainty in Afghanistan. This changes the whole market structure. Interestingly, most of externalities have geographical or political origin.

- In the case of gas market we have a clear intertemporal problem, because associated investment in infrastructure is durable. The problem is the conflict between low flexibility of long term contracts and the desirability to secure the investment in infrastructure.

Yegorov, Wirl IAEE 2009
Necessity for new approach. 2

Gas market is characterized by:

- Preferences of consumers (that can also evolve over time, as the response of product availability for particular consumer);
- Production functions (also evolving, taking into account depletion of resources and new discoveries);
- Optimization of extraction paths given market structure and rational expectation about its evolution (a typical model in resource economics);
- Optimization of sequence of investments in different infrastructure (subject to perturbations due to externalities and new discoveries);
- Price pattern (the function of both space and time)

This is a very complex problem, and it makes sense to start analysis from more simple. One of them in the complex analysis of origin and structure of transit games. Another is related to spatial oligopoly, with Hotelling’s (1929) approach.
• Gas transit gives rise to different types of games, and both geography and politics determine their structure. Geography often prevents competition, especially in the case of unique pipeline via third country. If this pipeline transit generates revenue above cost level, we have emergence of pie, with pie-splitting game.

• In principle, there are many possibilities of structures of transit games, and some of them will be considered below. Here we do not focus on modelling Ukrainian transit, but can refer to other studies related to its modelling: Hirschhausen et al (2005), Victor & Victor (2006), Yegorov & Wirl (2009).

• We focus on the transit game with transit country as net exporter. The game emerging from the transit of gas from Turkmenistan via Russia is theoretically richer because here a transit country is also net gas exporter with substantial market power.
Modelling Gas Games. 2

This problem (Turkmen gas) can be decomposed into two sub-problems:

• bargaining between Russia and Turkmenistan over gas price PT;
• optimization problem of Russia taking into account demand function and bargaining outcome.

• In principle, there exist many possibilities of formal modelling. We can take into account market power of Russia (large producer) in influencing European gas price (as we do below) or neglect it (considering European price fixed). The model can consider or neglect the growing marginal cost of Russian gas. Here we consider the mix of monopolistic optimization and bargaining, the set up that reflects well the nature of the process but has not been studied in economic literature. The main focus is on contrast between internationally regulated and non-regulated transit.
Modelling Gas Games: Results

• We see that pie size depends on Russian strategy, and it is transit producing country (here Russia) who defines the game. In the considered case Russia allowed all gas from Turkmenistan to be transited, but then bargained with it about price on the border. The different models of transit relations demonstrate that both the emergence of game and its structure depend on geography, internationals laws and politics.

• Let us focus on structural differences emerging from economics and geography. The main structural difference between cases A (Ukraine as transit country) and B (Russia as transit country) is in export property of that country. While Ukraine is net gas importer, Russia is net gas exporter.

• Thus, while export of Russian gas via Ukraine only exploits its pipeline infrastructure, export of gas from Turkmenistan via Russia besides that has also an impact on Russian export price.
About Spatial Pricing of Gas

The market structure (for gas from Turkmenistan - over Russia) is an outcome of its location and geopolitical obstacles. Nowadays, there are many discussions about NABUCCO. Hartley and Medlock (2009) predict the preservation of dependence of Central Asian countries on Russian transit in future. The problem is not in the delay of constructing NABUCCO but how little it changes the situation for Turkmenistan. Given that alternative transit cost may be as expensive for Turkmenistan as its present transit via Russia, it will only upgrade bargaining power of Turkmenistan in its game with Russia.

The problem is the distance. It is likely that the cost of transit of Russian gas over Russian territory is comparable or even higher than the cost of its extraction. This partly justifies the difference between Russian domestic price for gas and price for its export. But the similar argument can also be applied to Turkmenistan. We argue that even in competitive transit environment, the price of natural gas on the border of Turkmenistan should be substantially lower than European price, simply because of high cost of competitive transit.
Can Games Be Reduced?

• What factors can influence the structure of transit games?
• In the short run, this may be updating of international law. In the long run, it is more geopolitics that can prevent the construction of alternative pipelines either by direct blocking or worsening of investment climate.
• Transits allow for power abuse, which can put exporting country with no direct access to consumers into a weak position. In these examples we have seen that one country (here Russia) can be in different positions: abused by Ukraine and abusing Turkmenistan.
• If we start from the rights of producers and consumers to contract directly, then bargaining power of transit countries can be reduced or eliminated by corresponding amendments to international law. However, since geopolitics also influences such legal decisions, we do not always observe economically efficient legal implementations.
Spatial Oligopoly for Gas. 1

• Here we will touch another aspect of gas market that is related to its spatial structure. If gas pipeline network is rather dense and if we have few suppliers (with particular spatial locations), then we can use the approach of Hotelling (1929).

• The two-dimensional set up has been elaborated by Yegorov (2000). As it was shown in Yegorov (2000), introduction of special coordinates (elliptic-hyperbolic, with location of production points in focuses) after integration allows to write the corresponding model as 1-dimensional Hotelling model with firms at the end of interval and some heterogeneous demand density. For a broad set of densities such a problem has Nash equilibrium in pure strategies for linear transport costs, and thus the criticism of original Hotelling's model by d'Aspremont, Gabzgewich and Thisse (1979) does not apply.

• It is also shown that for rich class of non-uniform densities Nash equilibrium in pure strategies also exists.
Spatial Oligopoly for Gas. 2

• The objective is to apply this model for the case of European gas market. While in reality many producers export natural gas to EU, for simplicity we can concentrate on two main suppliers at present: Russia and Norway. According to BP Statistics, natural gas imports from Russia and Norway form 100 % of gas imports for 8 European countries, between 50 and 100 % - for 10 more countries, and less than 50 % for only 8 countries.

• Two-dimensional Hotelling model (Yegorov, 2000) can be used for the description of spatial competition between producers of natural gas (Russia and Norway) and European consumers. Locations of production are fixed (immobile), gas transport network in Europe is dense (see map 1) and consumers (demand density) are heterogeneous. While in classical Hotelling model for any pair of prices there is only one indifferent consumer, in 2-dimensional set up with Euclidean metric, indifferent consumers are located on hyperbola.

• The function $Y=R/(R+N)$ (relative weight of imports from Russia) is regressed on index $0<x<1$ (relative location of a country).
Table gives the shares of Russian (R) and Norwegian (N) gas for different consumers in Europe. Also, location of countries is characterized by x – coordinate on the interval 0<x<1 connecting gas entry points of Norway (x=0) and Russia (x=1). See the map.

Next graph gives regression of Russian share in gas imports, R/(R+N), on location x.
Dependence of Russian share in gas imports on country’s location \( x \)

Plot \( \frac{R}{R+N} \) as function of distance \( x \)

\[
y = 1.0698x + 0.0589 \\
R^2 = 0.8543
\]

Yegorov, Wirl IAEE 2009
Conclusions

• Markets for natural gas can be modelled in a theoretical way. We have a set of consumers with their preferences for gas and gas producers in different location, with asymmetric access to the market; a set of links (spatial) and contracts (temporal) between them; investors who invest in links between producers and consumers; potential investment projects, among which investors choose those with higher NPV under current geopolitical conditions.

• Links between producers and consumers are evolving over time. It makes sense to focus on reductions like gas transit games and geopolitical externalities. Analysis of simple models related to gas transit games and Hotelling-type spatial competition and gas transit games reveal that geography and politics play at least as important role as economics in modelling of real gas markets.
Thank you for your attention!

• Our e-mails:
  yury.egorov@univie.ac.at, Franz.wirl@univie.ac.at