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Strategic Eurasian Natural Gas Model for Energy Security and Policy Analysis

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This paper presents the mathematical formulation of a large-scale equilibrium natural gas simulation model that covers gas markets of the EU and the Former Soviet Union. Although large-scale natural gas models have been developed and used for energy security and policy analysis quite extensively, the model presented in this paper differs from earlier ones in its detailed representation of the structure and operations of the Former Soviet Union (FSU) gas sector.

The validation of the model with historical data shows that in general the model's results are in line with actual market outcomes for the years 2008 and 2009, and that the behaviour of the model is consistent with economic intuition. Moreover, the sensitivity analysis shows that the model's results are fairly robust in terms of major structural assumptions.

The model was demonstrated by analyzing a Base Case scenario of European gas market development (2010-2030) in which only producers may exert market power while all other market participants are assumed to be price-takers. Findings from this scenario suggest, among other things, that in light of the decline in indigenous gas production in Europe, the role of Russian gas is still important but quite limited (between 2010 and 2030 the market share of Russian gas increases modestly from 26% to 32%), and that Europe's growing import requirements are increasingly met with LNG imports (the market share of LNG expands from 26% in 2010 to 34% in 2030). We also found that once the Nord Stream and South Stream pipelines become operational, the role of transit countries, especially Ukraine, in transporting Russian gas to Europe becomes rather marginal. However, gas flows through the Yamal-Europe pipeline (Belarus) are not affected by these two pipelines.

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To further demonstrate the capability of the model, a social benefit-cost analysis of the Nord Stream gas pipeline project from Russia to Germany via the Baltic Sea is provided. It was found that investment in Nord Stream is unattractive to its investors only when all market participants are price-takers (which does not conform with current market realities), whereas under market power scenarios Nord Stream appears to be an economically attractive project to its investors (Gazprom and European energy companies). We also found that the value of Nord Stream investment is rather sensitive to the degree of downstream competition in European markets. In general, the economics of the Nord Stream pipeline system are mainly driven by: (i) lower total transport costs from different production regions in Russia to final consuming markets in Europe compared to the Ukrainian route and the Northern Light system (Belarus), (ii) the changing geography of gas production in Russia which also modifies Gazprom's transport cost structure in favour of the Nord Stream route, and (iii) the possible exercising of market power by transit countries (Ukraine and Belarus).

Without a detailed representation of the FSU gas "region" in this model it would not be possible to see that Nord Stream can be an economically profitable project compared to the Ukrainian route and to the Belarusian Northern Light system (at least in our oligopoly simulations), without strategic bargaining considerations. Using the large-scale gas simulation model, we also were able to analyse the Nord Stream project in terms of market efficiency and social welfare. Here, it was found that Nord Stream improves market efficiency in all market power scenarios, and that the higher the degree of competition between market participants, the more European consumers gain.

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