Energy Policy 106 (2017) 288–297

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Economic impacts of natural gas flow disruptions between Russia and the EU

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ARTICLE INFO

Keywords:
Natural gas
Supply shocks
Non-linear programming
Russia
European Union

ABSTRACT

In this paper we use a non-linear programming approach to predict the wider interregional and interindustry impacts of natural gas flow disruptions. In the short run, economic actors attempt to continue their business-as-usual and follow established trade patters as closely as possible. In the model this is modelled by minimizing the information gain between the original pattern of economic transactions and the situation in which natural gas flows are disrupted. We analyze four scenarios that simulate Russian export stops of natural gas by means of a model calibrated on an international input-output table with six sectors and six regions.

The simulations show that at the lower levels of aggregation considerable effects are found. At the aggregate level of the whole economy, however, the impacts of the four scenarios are negligible for Europe and only a little less so for Russia itself. Interestingly, the effects on the size of the economy, as measured by its GDP, are predominantly positive for the various European regions, but negative for Russia. The effects on the welfare of the populations involved, however, as measured by the size of domestic final demand, have an opposite sign; with predominantly negligible but negative effects for European regions, and very small positive effects for the Russian population.

1. Introduction

In aiming to ensure a resilient energy system, the European Union (EU) initiated an extensive energy policy package (European Commission, 2015). Natural gas is given an important role in meeting future EU-wide energy demand. It can be flexibly produced and stored, and therefore represents a good backup for intermittent renewable energy. Significant natural gas demand growth and demand variability is foreseen, especially for certain regions (Smith, 2013). Due to dwindling EU natural gas reserves, dependency on non-EU gas flows will increase. Anticipating these developments, multiple far-reaching measures have been taken in order to arrive at a single well-functioning internal gas market. The continuing integration of the gas market also contributes to larger gas flows across all EU countries.

Russia is one of the main suppliers of natural gas to the EU-market (International Energy Agency, 2014). Russia exports its natural gas to Europe via pipelines, which requires crossing the territory of third countries, like Ukraine. Over the years, problems between Russia and Ukraine have had their impact on natural gas flows to the EU. The 19-day complete disruption of transit flows via Ukraine at the start of 2009 has been the worst incident so far (see Pirani et al. (2009) for details). It impacted consumers in several East European countries, mainly through problems with district heating, but the alleged impact on industrial output could not be separated from other possible causes of change (Kovacevic, 2009). On January 20th of that year, supply was reinstated after signing a 10-year transit contract; the current transit contract between Gazprom, Russia's main natural gas producer and monopolist of pipeline exports, and Naftogaz, owner of the pipelines in Ukraine. This contract will thus end in 2019. Although both the European Union and Russia have been working on diversifying the transit routes, the reliance on Ukrainian transit capacity will still be sizeable in 2019, which may again lead to problems (Pirani and Yafimava, 2016).

On the other hand, Russia is also actively pursuing strategies to diversify away from Europe and to generate gas export revenues elsewhere (Dickel et al., 2014; Shadrina, 2014). The focus is currently on developing gas fields in East Siberia for East Asian markets. Over the past years demand from this region has increased, resulting primarily in the development of LNG investment projects (Motomura, 2014). Even though the recently agreed contract with China includes building a pipeline called the 'Power of Siberia', that is currently being constructed, it is not expected to be operational before

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http://dx.doi.org/10.1016/j.enpol.2017.03.030
Received 11 January 2016; Received in revised form 24 February 2017; Accepted 11 March 2017

2020 (International Energy Agency, 2014).[1] In addition, this pipeline will not directly compete with exports to Europe, as it is built east of Mongolia and does not connect to the European network.

The pipeline that would allow Russia to alternate gas flows between Europe and China, to be build west of Mongolia through the Altai Republic, however, only represents a sketchy plan (Dickel et al., 2014). Russia's advancements over the years have been very haphazard for several reasons, among which the global economic crisis, technical difficulties in developing these East Siberian fields, and lengthy negotiation processes (Fernández and Palazuelos, 2011; Henderson and Stern, 2014). Still, with subsequent energy strategies, Russia has become more positive about the share of gas that will be exported to East Asia, reaching over 30% by 2035 (Shadrina, 2014). Paltsev (2014) has confirmed the feasibility of this scenario using a modelling approach. Impacts on the European market, in terms of diversion of flows elsewhere, however, are likely to be limited, although Russia may be able to take a stronger bargaining position after 2050 (Orlov, 2016).

The renewed Ukraine-Russia turmoil over the past years has again increased the tension between the EU and Russia. Alternative routes, via Belarus (Yamal pipeline) or via the Baltic Sea (Nord Stream pipeline) offer spare capacity, but not enough to fully replace transit flows through Ukraine (Pirani and Yafimava, 2016). The European Commission has published a reinforced energy security strategy, focusing on more resolute actions to diversify supply and strengthen the internal infrastructure in order to promote resilience to disruptions (European Commission, 2014a). This strategy is a response to mitigate the EU's dependence on Russia as natural gas supplier and on Ukraine as main transit country. To assess EU's vulnerability to Russian gas supplies, the European Commission has, furthermore, undertaken a stress test to see whether the EU would be able to get through a winter without any imports from Russia. The sources expected to contribute most to the alternative supply of natural gas are Norway, LNG, and underground storage facilities in the EU. Only in case all Member States cooperate, no household would have to be affected. The Eastern Member States and former Yugoslavian countries would be affected most (European Commission, 2014b).

Ex-post modelling of the 2009 Ukraine incident showed that, given the available infrastructure and storage, the European gas industry dealt with the crisis in nearly the best possible way (Lochner, 2011). The mild winter and the economic crisis had caused storage levels to be higher than usual, which mitigated the impact of the crisis. Still, a small increase in the flexibility of pipelines, i.e., making reverse flows possible, would have significantly improved the security of supply in Eastern Europe. Richter and Holz (2015) show that the average impact on the EU would be limited to slightly higher prices, at least in their short term disruption scenarios. Again, certain East European countries are much more severely affected. The long term disruption scenario has much more impact. The authors see an important role for LNG, although large investments in transportation infrastructure would be needed to accommodate these flows. Egging and Holz (2016) investigate a scenario in which transit of Russian gas via Ukraine is disrupted from 2020. Again, the role of LNG is confirmed, and the authors remark that Poland has started to become a transit hub. Interestingly, Egging and Holz (2016) also claim that China will be dominating the global natural gas market in the future in all their scenarios, even despite the possibility of significant climate policy efforts that may be undertaken (Holz et al., 2015).

The strong international dimension of the gas market implies that any supply shock will be propagated extensively through the network. Not only in terms of the physical flows of natural gas, but also in terms of the economic impact of gas flow disruptions. In this paper, we investigate the *wider economic* impacts of disruptions in the supply of natural gas with a *new approach*. A non-linear programming model is used to predict the short and medium term interregional and inter-industry impacts of four disruption scenarios. In the model, these impacts are determined by the hypothesized attempts of economic actors to continue their business-as-usual, as much as possible, by staying as close as possible to their established trade patterns. This behavioral response to a disruption is implemented by minimizing the difference between the pre- and the post-disruption pattern of economic transactions.

Several scenarios will be analyzed based on data from the EXIOPOL international input-output database (see Tukker et al. (2013)), because this database includes a separate natural gas extraction sector. The set of scenarios we study focuses on the fact that Russia may decide to stop the export of natural gas. This could be a total ban on all exports to the EU, in its most extreme form. More realistically, it may be a setting in which only particular cross-border flows are hampered. For example, physical pipelines may be damaged, or Russia may decide to limit cross-border flows to certain European regions for political reasons. These situations will be simulated by reducing or removing the economic transactions related to the flows of natural gas between countries. Limited changes in gas supply can be accommodated by the gas infrastructure of the EU, because of redundant capacity for security of supply reasons. However, due to limited transport capacity, or limited possibilities to extract additional gas, natural gas quantities that can be supplied in the short and medium run will be limited.

Our type of analysis of the economic impacts of natural gas flow disruptions will inform policy makers on the order of magnitude of the wider economic impacts from disruptions in the supply of natural gas. The results also identify critical gas supplier relations for the economic functioning of the Member States and strains on the rest of the economic system following a gas supply disruption. Our type of approach could also be used to further investigate mitigation strategies, such as diversifying supply or investing in additional infrastructure.

2. Modelling methodology, data and scenarios

The model used mimics that, in the short run, economic actors attempt to continue their business-as-usual, and attempt to follow established trade patters as closely as possible. This behavior is simulated by minimizing the information gain between the original pattern of economic transactions between all industries and all regions distinguished, as shown in the base year interregional input-output table (IRIOT) at hand, and the situation in which the flow of natural gas is disrupted, as captured by the measure originally proposed by Kullback (1959) and Theil (1967). Here, we use a slightly adapted version of the information measure that is referred to as IGRAS (Huang et al., 2008). Our type of model was first set-up to analyze the impact of natural disasters (Oosterhaven and Bouwmeester, 2016, see also Koks and Thissen, 2016), but it is also suited to simulate the impacts of trade boycotts. See Oosterhaven (2017) for the reasons of choosing this modelling approach above, e.g., the standard extended input-output (IO) model, the inoperability IO model or the hypothetical extraction method.

Our modelling approach focuses on all economic relations for the entire economies of the regions included, which allows us to analyze the impact of the disruption scenarios for the entire economy. Other models used in the literature for disruption analysis concentrate on the natural gas production sector and/or the natural gas transport infrastructure. The TIGER model, used by Lochner et al. (2010) and Lochner (2011), is a linear optimization network flow model that minimizes the cost of natural gas demand satisfaction, constrained by the available capacities of over a thousand infrastructure elements. The Global Gas Model is a partial equilibrium model set up as a large-scale mixed complementarity problem, with high detail on storage and transportation infrastructure (Richter and Holz, 2015); a stochastic variant also exists (Egging and Holz, 2016). The model solves for long-

[1] See also: http://neftegaz.ru/en/news/view/154118-Gazprom-s-Power-of-Siberia-pipeline-set-for–2020-launch.