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Assessing gas transit risks: Russia vs. the EU[☆]

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ABSTRACT

This paper proposes a Transit Risk Index (TRI) designed to assess the riskiness of pipeline gas imports and to study the effect of introducing new gas routes. TRI controls for gas dependency, transit route diversification, political risks of transit, pipeline rupture probability, and the balance of power between supplying and consuming countries along the transit route. Evaluating TRI for the EU-Russia gas trade, we show that the introduction of the Nord Stream pipeline would further widen already large disparities in gas risk exposure across the EU Member States. The gas risk exposure of the Member States served by Nord Stream would decline. In contrast, EU countries not connected to Nord Stream, but sharing other Russian gas transit routes with the Nord Stream countries, would face greater gas risk exposure. We discuss the implications of our analysis for the design of the common energy policy in the EU.

1. Introduction

For a number of years, Russia has been the largest supplier of natural gas to the EU and naturally, the EU's dependence on Russian gas often has been the focus of political and public debates. Concerns about this dependence, and especially about the security of the gas supply, have intensified in the last five years as the EU faced repeated shortages, or even stoppages, of Russian gas.[1] For example, during the 2006 gas crisis between Russia and Ukraine some Western European countries experienced a sizable reduction in their gas supplies. Another Russia–Ukraine gas conflict in January 2009 left South-eastern Europe completely without Russian gas for almost two weeks, and caused severe shortfalls of gas in a number of other Western European countries. More recently, in June 2010 Belarus threatened to shut down the energy route that goes to Europe. While the threat was implemented only towards Lithuania, with 40% of Russian gas supplies cut, EU Energy Commissioner Guenther Oettinger characterized this reduction as "an attack against the whole EU".[2]

These episodes show that transit is a very serious aspect of the security of the EU's external gas supply. The aim of this paper is to incorporate the transit dimension into the more conventional measure of risks associated with pipeline gas imports, and to use the resulting index to study the effect of new gas routes on the security of supply.

Transit might influence gas supply risks in several ways. First, the extent to which a country is affected by a supply disruption may depend on the availability of alternative transit routes from the involved supplier. Indeed, during the 2009 Russia–Ukraine crisis Gazprom replaced up to half of the resulting gas shortage to Poland, Germany and Czech Republic by increasing supply via the Yamal pipeline passing through Belarus.[3] Second, the configuration of transit routes may influence the allocation of bargaining power in the supplier-consumer gas relationship. For example, Poland's objection to the creation of Nord Stream has been widely attributed to the fear that if Germany gets a direct pipeline from Russia, it would no longer use its political influence to resolve potential gas conflicts over the Yamal pipeline currently serving both Poland and Germany. As a result, it would be less costly for Russia to use its gas supply to Poland as an instrument of political pressure. In 2009 the Wall Street Journal even referred to the Nord Stream project as the "Molotov-Ribbentrop pipeline".[4] Next, supply continuity may be affected by a physical rupture of a pipeline as, for example, in April 2009 when an explosion of a transit pipeline in Moldova nearly halved Russian natural gas supplies to Balkan countries.[5]

Motivated by these examples, the paper suggests a framework for a quantitative assessment of risk associated with pipeline gas imports. We construct a Transit Risk Index (TRI) that combines the standard supply security factors, such as gas dependency,

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[1] See, e.g., Goldthau (2008) and Finon and Locatelli (2008) for an overview of the EU–Russia gas relation and of the risks associated with Russian gas supply.

[2] Schwirtz (2010).

[3] Gas Coordination Group (2009).

[4] Petersen (2009).

[5] Socor (2009).

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with a set of physical and political aspects of pipeline transit risk. In particular, TRI controls for (a) diversification of transit routes from a given supplier, (b) risk of pipeline rupture, (c) political instability in the transit countries, and (d) the balance of power for each transit route. Gas dependency, political risks of transit, and the risk of pipeline rupture increase TRI, while more diversified transit routes and stronger bargaining power of countries served by a transit route decrease it. Higher values of TRI, then, imply a higher level of risk in the external gas supply.

Next, using TRI approach we evaluate the EU Member States' exposure to risks associated with the Russian gas supply. First, we estimate the TRI index for the current gas trade between Russia and the EU. We observe a clear asymmetry in the transit risk exposure among the EU Member States purchasing Russian gas. This unsurprising finding reflects the variation across the Member States in terms of gas dependency, the number of available gas transit routes, the political influence associated with each route, and so on. Further, contrary to the growing concern about dependency on Russian gas, we find no clear trend over time in the risk associated with the EU's consumption of Russian gas. Some of the EU Member States experience an increase in their individual risk exposure levels, others a decrease, and for a third group the TRI does not change much. Overall, the picture appears rather stable over last decade, suggesting that the main complication for the EU's gas trade relationship with Russia would likely stem from uneven risk exposure across the Member States, rather than from an overall increase in dependency. This view is shared by e.g. Noël (2008, 2009).

The paper proceeds to study how the EU Member States' risk exposures would be affected by the introduction of a new transit route. We take the example of Nord Stream, and consider different scenarios depending on the level of capacity at which Nord Stream operates.

We show that the introduction of Nord Stream is likely to divide the EU Member States into three groups. The first consists of the Member States served by Nord Stream (thereafter "NS countries"). For this group, introducing Nord Stream would lower the transit risk exposure due to better gas route diversification. However, this no longer holds true if Nord Stream is utilized at full capacity. In that case, the NS countries' TRIs (and their risk exposures) would increase due to imbalances in the allocation of gas imports across the transit routes. The second group is made up of the Member States that are not connected to Nord Stream themselves, but that share another "older" transit route with the NS countries. Nord Stream's introduction will raise this group's transit risk exposure, since the NS countries would be less interested in exerting political pressure to resolve a conflict between Russia and the transit countries. Therefore, this second group of countries would lose some bargaining power vis-a-vis Russia in the consumer-supplier relationship along the "older" transit routes. Moreover, the risk exposure of this second group of countries would worsen with greater Nord Stream utilization. Thereby, both the NS countries, and the Member States not served by Nord Stream, but sharing another transit route with the NS countries would lose from full utilization of Nord Stream. This finding suggests that it is unlikely that Nord Stream will be run at full capacity, implying that the worst-case scenario for the second group will not materialize. Finally, the remaining Member States buying Russian gas would not be affected by the launch of Nord Stream.

There is a sizable literature that proposes energy security indicators differing in approach and focus (see Kruyt et al. (2009) or Cherp and Jewell (2011) for a review). The central point of our paper – an assessment of gas transit risks – is however largely overlooked in the energy security index literature. Where transit has been considered, the measure is often opinion-based or simplistic. For example, Scheepers et al. (2007) include transportation risks in their Crisis Capability Index, but their measure is based on expert evaluation of risk weighted with the share of respective fuel in total imports. Le Coq and Paltseva (2009) approximate the risk of fuel transportation by the distance between the energy-producing and consuming countries. While either approach is suitable for fungible fuels such as (non-pipeline) oil or LNG, it would likely not suffice to capture the specificity of pipeline gas transit. Our index focuses on the riskiness of pipeline gas transit, accounting for diversity of transit routes, political risk of transit, risk of pipeline rupture, and the change in the bargaining power vis-a-vis supplier.

Another related branch of literature addresses the future of gas transit in Europe using numerical methods. For example, Lochner and Bothe (2007) and REACCESS (2011) assess the economic viability of newly built and planned gas corridors. However, they do not specifically address the transit-related threats to the security of gas supply. Hartley and Medlock (2009) examine the future evolution of Russia's position as a dominant supplier in the EU gas market. One of their scenarios studies the case of an abrupt interruption of Russian gas supplies to Europe. However, they do not address the relative effect of such a supply interruption on different EU Member states, which is one of the key questions in the current paper.

Our paper is also related to the literature studying the strategic component of Russian gas trade with Europe based on game-theoretical approach. Most of this literature assumes that the dominant position in the game is either taken by Russia or shared between Russia and the transit countries, with Europe being a relatively passive player. For example, von Hirschhausen et al. (2005) focus on the strategic interaction between Russia deciding on the gas supply disruption, and Ukraine setting the transit fees. Grais and Zheng (1996) or Morbee and Proost (2010) analyze the relationship between Russia and Europe when "strategic" disruption reduced the European demand for Russian gas. In all three papers, Europe is considered as a price-taker in the market. Thereby the role of the EU in these strategic interactions is rather limited.

However, not only Russia is the largest gas provider to the EU; also the EU consumes 90% of Russian gas exports, making the EU a powerful actor in the gas relationship with Russia. In our approach we account for the EU bargaining power. While this argument recently started receiving more attention in the literature (see, e.g. Finon and Locatelli (2008)), to our knowledge, the only papers that explicitly model and derive the EU's bargaining power in the gas relations with Russia are Hubert and Ikonnikova (2011) and Hubert and Suleymanova (2008). Similarly to these papers, we assume that such bargaining power depends on the configuration of the gas network. However, Hubert and Ikonnikova (2011) and Hubert and Suleymanova (2008) use the cooperative game theory approach to identify the power structure along the pipeline. Further, they focus on investment options, not on energy security.

The paper is structured as follows. We present the methodology used in constructing the Transit Risk Index in Section 2. Section 3 describes the data, provides the index calculated for the EU Member States currently purchasing Russian gas, and shows how the index can be used to illustrate the impact of Nord Stream on the gas supply security of the Member States. Section 4 discusses possible extension of our framework. In Section 5 we summarize our findings and address some policy implications.

2. Methodology

This section addresses our approach to constructing a Transit Risk Index (TRI) that assesses EU countries' risk exposures associated with the external supply of pipeline gas. To simplify the exposition, we first consider the case of gas imports from one supplying country. Later, in Section 4, we discuss how our methodology can be extended to a more general case of multiple suppliers.

Our measure of risk exposure, the TRI, includes both the conventional determinants of the security of external supply that are applicable to all fuels, and the specific determinants, reflecting the risks associated with the pipeline transit.

The first group of determinants consists of the import dependency ratio, measured as the net imports from the considered supplier in the country's total gas consumption, and the share of gas in the energy bundle of the consuming country. The former component represents the country's dependence on this supplier, while the latter represents the overall gas dependence of the country.

Before addressing the second, transit-related group of determinants, we need to give a more precise meaning to the concept of the transit route used in this paper. Recall that most of the EU's problems with gas transit have arisen from conflicts between Russia and so-called transit countries, Ukraine and Belarus. In this context define an entry node as a location on the border between a transit country and the EU. Then define a transit route as an entry node plus the pipeline system following this node on the way from the supplier, so that each transit route would be associated with one specific transit country and a group of gas-consuming countries it is serving.

Now turn to the transit-related group of TRI components. There are various ways in which transit and transit routes could affect the security of the gas supply. To begin with, take the availability of alternative routes connecting the supplying and the consuming countries. The idea here is that better diversification of transit routes, both within and across the transit countries, would improve the security of the external gas supply. To capture transit diversification our index includes a sum of squared gas import shares for different transit routes, similarly to the Herfindahl-Hirschman index.

Further, each of the alternative transit routes possesses a number of specific features, which may matter for the transit risks. First, gas transit may be affected by the physical failure of the pipeline. Second, the continuity of gas supply may be influenced by political instability along the transit path. Third, the supplier's decision to cut off gas deliveries, and the duration of a cut-off, may depend on the extent of political pressure from the affected consuming countries. Consider the group of countries served by a particular transit route. Naturally, economic or political partnership with these countries has a certain value for the supplier. The more valuable this partnership is to the supplier, the more power this group of countries has in its relationship with the supplier. For example, if these countries constitute a large share of supplier's gas market, they would possess a buyer power. This power, in particular, would allow the group to discourage the use of gas deliveries as a political tool should a conflict arise between the supplier and a transit country.

Based on the above reasoning we construct a Transit Risk Index (TRI) for gas-consuming country c, defined by the following equation:

$$TRI_c = \left[\sum_{i \in Routes_c} \left(\frac{I_c^i}{I_c} \right)^2 \times RuptRisk_c^i \times PolRisk_i \times BP_i \right] \left(\frac{I_c}{Cons_c^{Gas}} \right) SG_c, \quad (1)$$

where:

- $Routes_c$ is the set of transit routes from the considered supplier to country c, with $i \in Routes_c$ indexing individual routes in this set;
- I_c is the total imports of gas from this supplier to country c, and I_c^i is the amount of country c's gas imports via transit route i;
- $RuptRisk_c^i$ is the measure of the risk associated with the physical rupture of the pipeline. It is known that the frequency of pipeline rupture is proportional to the length of the pipeline.[6] Thereby, $RuptRisk_c^i = L_c^i \times PRup$, where L_c^i is the length of the transit route i to the border of country c, and $PRup$ is the probability of a rupture per km within a considered period of time;
- $PolRisk^i$ is a measure of political instability along the transit route. It incorporates instability both in the supplier country and in the transit country (ies);[7]
- BP_i is the measure of bargaining power vis-a-vis Russia possessed by the group of EU Member States served by the transit route i. If a considered gas route i transmits a large share of Russian gas imports, the countries served by this route would have a substantial buyer power. Further, the more coordinated are the buyers served by the route, the higher is their bargaining power vis-a-vis Russia. Finally, in a hypothetical situation of a single seller (Russia) and a single perfectly coordinated buyer (the EU) the bargaining power would likely be split evenly.[8] Our measure considers the deviation of the bargaining power of countries served by route i from this hypothetical threshold:[9]

  $$BP_i = \frac{1}{2} - MS_i \times BC_i$$

  where MS_i is the share of Russian gas imports through route i in total Russian gas imports to the EU, and BC_i is the measure of gas buyer concentration along route i, used to approximate the extend of coordination between the countries served by this route. Thereby, lower values of BP_i imply higher bargaining power along a route and imply less risky gas imports;
- $Cons_c^{Gas}$ is the total gas consumption in country c and SG_c is the share of gas in country c's aggregate energy consumption.

The relative importance of the physical interruption risk, political instability or buyer power for the transit risk is not obvious. The approach suggested by formula (1) takes a neutral stand, assuming equal weight of these three factors in evaluating the impact of each transit route on gas supply diversification. It should not be interpreted as a cardinal measure of transit risk. Instead, it is intended for an ordinal comparison of transit risk across countries and/or time.

To sum up, for each country TRI quantifies the risks of gas imports from a single supplier, placing a special emphasis on the transit dimension. Gas dependency, political risks of transit, distance between entry node and the consuming country all increase TRI, while more diversified transit routes and stronger bargaining power of countries served by a transit route lower the value of the index. So, higher values of TRI imply more risk in a country's external gas supply.

3. Estimating TRI

This section applies the above framework to the gas trade between Russia and the European Union. The data cover all EU Member States that are purchasing Russian gas via pipeline, except for Estonia and UK for which complete data were not available. First, we address the current levels of exposure to Russian gas import risks. We compute TRI for 2008, the most recent year for which the data are available, and discuss the

[6] See, e.g. The International Association of Oil & Gas Producers (OGP) (2010).

[7] We only consider non-EU transit countries risk here as we believe that the political risks of gas transit within EU are negligible.

[8] So that each party has the bargaining power of 1/2.

[9] $$MS_i = \left(\sum_{k \in \{\text{MS served by route i}\}} I_k^i \right) \Big/ \sum_{l \in \{\text{all EU MS}\}} I_l, \text{ and}$$

$$BC_i = \sum_{k \in \{\text{MS served by route i}\}} \left(I_k^i \Big/ \sum_{l \in \{\text{MS served by route i}\}} I_l \right)^2$$

evolution of risk levels in terms of TRI over the past ten-year period by comparing the 2008 index values to those for 2003 and 1998. Then, we use TRI to evaluate the impact of introducing Nord Stream on the gas transit risks of EU countries. We base our estimates on predicted EU gas trends in 2015 and compare TRIs under several scenarios.

3.1. Data

All actual data (i.e., for 1998, 2003 and 2008) on annual[10] gas imports from Russia, gas consumption and share of gas in total energy consumption are from Eurostat.

The predicted data on total (net) imports of gas and gas consumption in 2015 are taken from the European Commission publication “EU energy trends to 2030” (2010a, 2010b). We chose the year 2015 for two reasons. First, this is the earliest possible year with Nord Stream in use for which gas trend predictions from the European Commission are available. Also, at this date, Nord Stream would be the only new pipeline in use, as South Stream and Nabucco are likely to be introduced only after 2015. The predicted values for the gas imports from Russia in 2015 will depend on the chosen scenario, so we will return to this discussion below.

We identify transit routes between Russia and the EU Member States based on our definition from Section 2: as an entry node plus the pipeline system (and the country group) connected to this entry node. Using this definition yields nine different transit routes, with a number of EU Member states being served by multiple routes (see the Appendix for the description of each of the routes).

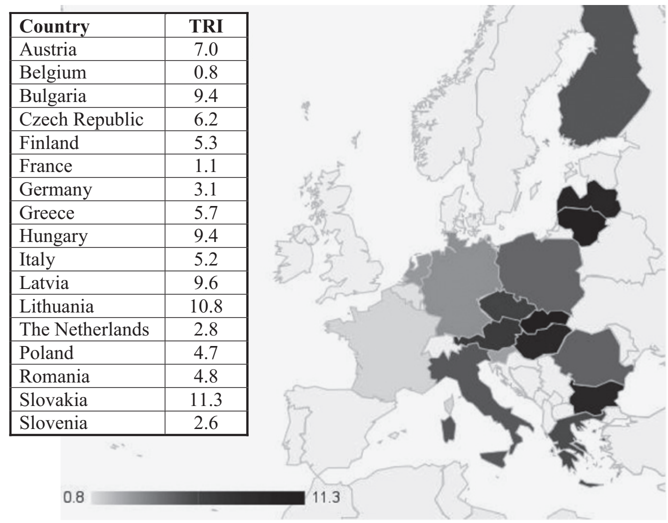
The data on the length of the gas pipelines come from a number of different sources: the European Regulators’ Group for Electricity and Gas (ERGEG) (2007), Wingas, Commission de régulation de l’énergie (2008), Kreuz (2006), and our own calculations.

The estimate of the probability of pipeline rupture is based on data from European Gas Pipeline Incident Data Group (2008) and International Association of Oil & Gas Producers (2010). As the rupture probability differs for pipelines with different wall thickness/diameter, we use the average incident frequency equal to 1.1×10^{-4} km/year for 2007.[11] Further, as we are interested only in short-term responses to gas supply shocks, we consider the probability of rupture per km-month, which would be roughly given by $PRup=10^{-5}$.

The measure of political risk of transit[12] builds on the 1998, 2003 and 2008 Political Risk Rating (PRR) suggested by the PRS group in their International Country Risk Guide. PRR ranges between 1 and 100, with higher values associated with lower risk. We construct a composite political risk index for route i using the PRRs for the supplying and transit countries, so that higher values are associated with higher risk[13]:

$$PolRisk_i = 1-\frac{PRS_{Russia}}{100}\times\frac{PRS_{TransitCountry\_i}}{100}.$$

To compute the transit diversification component of TRI, we need data on gas supplies by route for individual countries.



Country	TRI
Austria	7.0
Belgium	0.8
Bulgaria	9.4
Czech Republic	6.2
Finland	5.3
France	1.1
Germany	3.1
Greece	5.7
Hungary	9.4
Italy	5.2
Latvia	9.6
Lithuania	10.8
The Netherlands	2.8
Poland	4.7
Romania	4.8
Slovakia	11.3
Slovenia	2.6

Fig. 1. Transit Risk Index (2008).

However, to our knowledge, such data are not available. Therefore, we make approximations based on the total imports of Russian gas by each EU Member State and on characteristics of the transit routes serving this country. More precisely, we assume that the share of a country’s gas imports transported via each route is directly proportional to the capacity of the node where it enters the consuming country. The thinking here is that larger node capacity helps avoid transit bottlenecks, providing an incentive to increase imports through this route. This logic results in the following approximation for the by-route gas imports:

$$\widehat{I}_c^i = I_c\times\frac{Cap_c^i}{\sum_{all\_routs\_to\_c}Cap_c^j}, \tag{2}$$

where Cap_c^i is the capacity of node for route i at the border of country c. The data on node capacities are from European Network of Transmission System Operators for Gas (2010).

3.2. TRI: current gas risk exposure

Fig. 1 shows the results of 2008 TRI estimation. Not surprisingly, there is a large variation in TRI among the EU Member States. This variation reflects the Member States’ differences in terms of total gas dependency, reliance on Russian gas, the number of transit routes available to each country, and the political influence associated with each route (i.e., the group of countries sharing the respective route).

For example, countries like Belgium, France or the Netherlands have well-diversified transit and do not rely much on Russian gas. As a result, their TRI values are quite low. Germany has a considerable share of Russian gas in its consumption. However, it is served by two transit routes, one through Ukraine and one through Belarus. Each of these serves a group of countries that constitute a large share of Russian gas consumers, and is thereby associated with relatively strong bargaining power vis-a-vis Russia. As a result, Germany’s TRI is not much higher than Belgium’s or the Netherlands’ one.

At the other extreme there are Latvia, Lithuania, Bulgaria, Hungary, and Slovakia. All these countries purchase their gas almost entirely from Russia. Hungary, Bulgaria and Slovakia do not have well-diversified transits. On top of that, Latvia, Lithuania, and Bulgaria belong to small and non-influential transit routes.

[10] There is a large seasonal variation in gas consumption within the year, especially between summer and winter. So, a possible alternative would be to use the peak consumption figures. However, we had to limit our analysis to the annual data based on data availability.

[11] European Gas Pipeline Incident Data Group (2008), p.17.

[12] Recall that for each route we consider the political risk only of the source and the transit country(ies), ignoring the risks of the EU member states. Ideally, we would like to capture not only the political stability in the transit/supplier country per se, but also potential risks of a conflict between the supplier and the transit country in question. However, to our knowledge, such bi- (or multi-) lateral political risk data are not available.

[13] If there is no transit country on gas route i, the political risk measure is given by $PolRisk_i = 1-\frac{PRS_{Russia}}{100}$.

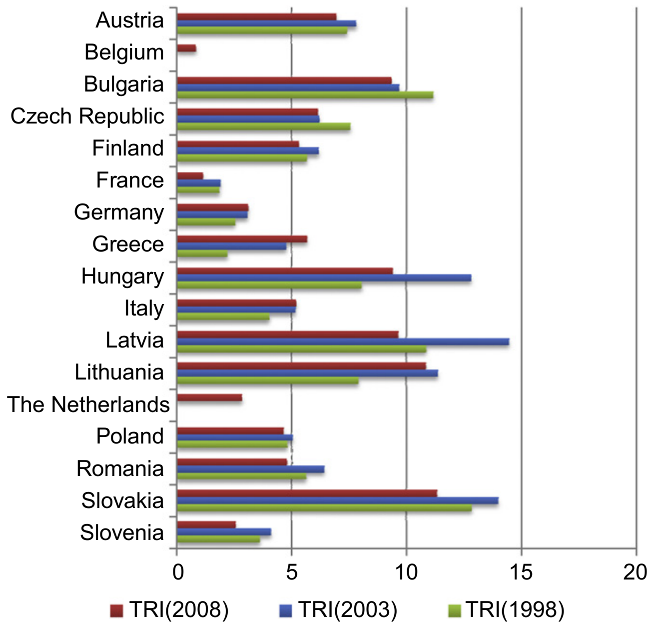


Fig. 2. Transit Risk Index 1998–2008.

Fig. 2 allows a view of the evolution of TRI over time (the respective numerical values can be found in Table A2 in the Appendix).[14] It presents the values of TRI for 2008, 2003, and 1998, respectively. We see no clear cross-country trend in TRI since 1998: for some countries (e.g., Germany) TRI increases, for others (e.g., Czech Republic) it falls, and for the rest the experience is rather mixed. But the overall pattern suggests that, with only a few exceptions (like Hungary or Latvia) TRI does not change much over last ten years.

Both of these observations suggest that the main worry with the EU's Russian gas supplies is not the increasing dependency (which is the most frequently voiced concern), but rather the uneven exposure across the Member States. These disparities may enable Russia to manipulate its gas trade with different parts of Europe applying a "divide and rule" tactic. Our findings are in line with Noël (2008, 2009) who argues that "the problem is divisiveness, not dependence" (Noël (2008)).

3.3. *TRI: the impact of Nord Stream*

Now let us see how the introduction of a new transit route might impact the gas supply risks in the EU. We focus on the case of the Nord Stream gas pipeline (henceforth NS), which links Russia with the European Union via the Baltic Sea. As of now it is slated to send natural gas to Germany, where it can be transported further to the Netherlands, Belgium, the UK, France and the Czech Republic. However, currently it is not completely clear whether any other countries will receive gas deliveries via NS. For simplicity we assume that the NS countries group is restricted to the above list of countries.

We consider three scenarios that differ in (i) the share of Russian gas in the total gas consumption of EU Member States and (ii) the utilization of NS capacity. Under each scenario we compute the 2015 TRI estimates for all EU Member States consuming Russian gas, and compare these across scenarios.

More precisely, Scenario 1 (labeled as No-NS scenario) is a hypothetical benchmark case in which NS is not used (or is not completed). Further, to estimate the TRI, we assume that the share of Russian gas in the total gas consumption of EU Member States is constant over time, so any increase in gas imports from Russia is proportional to the overall increase in gas consumption.[15,16] This assumption allows us to construct the 2015 Russian gas import values based on the 2008 data on Russian gas shares, and the 2015 predictions for overall gas consumption. We then use formula (2) to compute the allocation of 2015 Russian gas imports across the transit routes.

Scenario 2 (the NS-Conservative scenario) also assumes that the share of Russian gas in total gas consumption is constant over time. However, now we assume that NS is in place, and use rule (2) to calculate the predicted imports of Russian gas through different transit routes. A typical outcome would be that the NS capacity is underutilized.

Finally, scenario 3 (the NS-Full Utilization scenario) considers an extreme case where NS runs at full capacity.[17] Here we assume that for the NS countries the entire increase in gas imports (if any) is due to the increase in Russian gas imports via NS. The capacity of NS is shared between the NS countries proportionally to their gas imports from Russia, and the remaining gas imports are allocated across the transit routes according to formula (2). Notice that in this case, NS countries would likely "cannibalize" their gas imports through the old transit routes to fully utilize NS. For the countries not served by NS, the share of Russian gas imports is stable and formula (2) is universally applied.

As a reference point, compare the actual TRI for the most recent available data (i.e., 2008) to the projected TRI for the No-NS 2015 scenario. As Fig. 3 demonstrates, these indices are very similar, despite the predicted increase in overall gas consumption. This result is mostly explained by the absence of new transit routes in the No-NS scenario, as well as by the assumption of the constant share of Russian gas in total gas imports.

Now consider the impact of introducing a new energy route. Fig. 4 presents the TRI results for all three 2015 scenarios: the case of NS not being used (No-NS scenario), the case of NS being used as much as the other pipeline (NS-Conservative scenario) and full utilization of NS pipeline (the NS-Full Utilization).

Start by comparing scenarios No-NS and NS-Conservative. Fig. 4 reveals three different effects. First, we get lower TRIs for countries that have access to the new energy route. This predictable result is due to better transit diversification, as NS countries now have more transit routes available for use, and can thereby reduce their dependence on transit countries for the security of their Russian gas supply. Second, TRI increases for countries sharing other transit routes with the NS countries, such as Poland, Italy, Slovenia, Austria, Hungary, Slovakia, Lithuania, and Latvia. This effect is due to the loss of bargaining power along the older routes. Indeed, the NS countries become less interested in exerting political pressure to resolve conflicts between Russia and the transit countries; they may use NS in the case of a gas

[14] The 1998 and 2003 Russian gas imports data for Belgium and the Netherlands are not available.

[15] While overall gas imports in Europe have been increasing and are expected to continue so, the share of Russian gas in the total gas consumption has been rather constant over last years, see Fig. 5 in the Appendix.

[16] We also assume here that the imports of LNG would not have a large impact on Russian gas sales to the EU in 2015, see more discussion on it in Section 4.

[17] The option of running Nord Stream at full capacity was discussed repeatedly by representatives of Nord Stream AG and Gazprom (e.g. by Gazprom's CFO Andrei Kruglov, see Dow Jones Newswires, March 04, 2011, "Nord Stream Secures EUR 2.5 Billion Financing For 2nd Pipeline Stage").

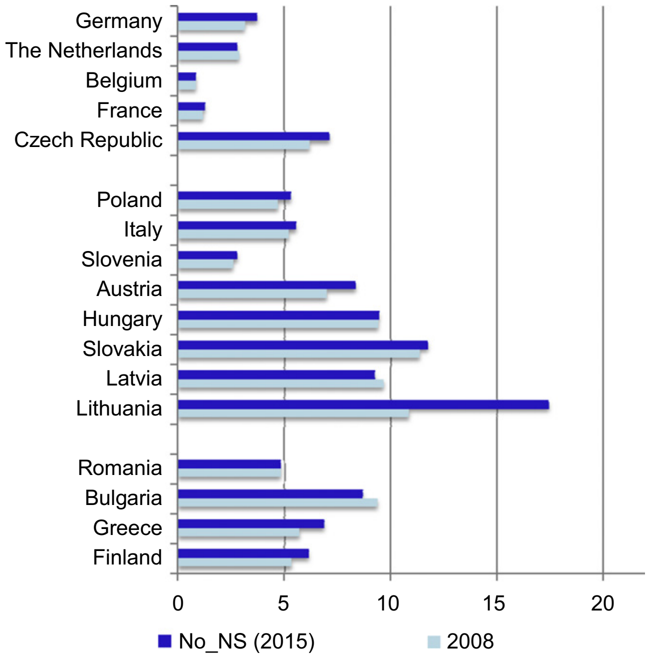


Fig. 3. Transit Risk Index: No-NS scenario vs. 2008.

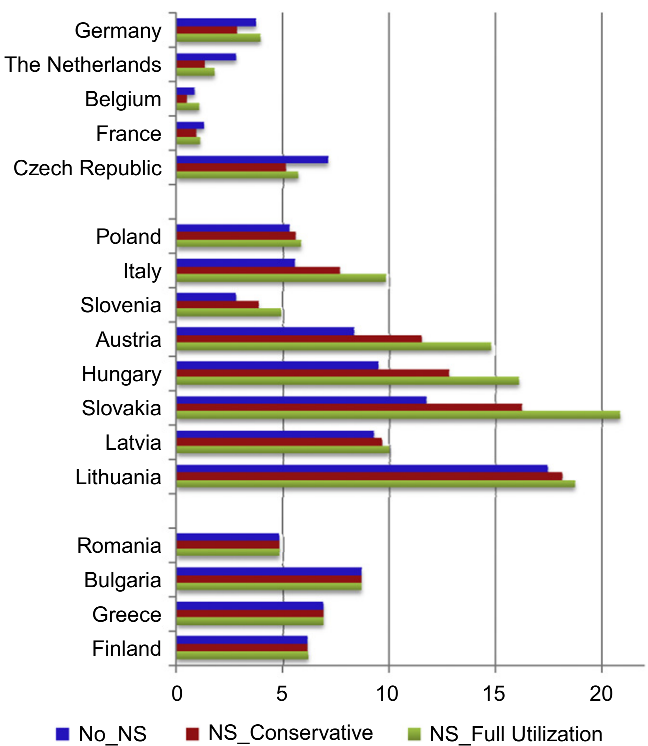


Fig. 4. Transit Risk Index: No_NS, NS_Conservative and NS_Full Utilization scenarios.

disruption. Third, for the countries that do not share energy routes with the NS countries (e.g., Romania and Bulgaria), the introduction of NS has no effect.

Now turn to the effect of increasing consumption of Russian gas to the extent of full utilization of NS capacity. Note that in this scenario, the NS countries would be able to minimize their exposure to transit countries. However, as we will now see, this option is likely to be costly.

Indeed, from Fig. 4 we see immediately that the NS-Full Utilization is the worst-case scenario for the EU Member States that share "older" pipelines with the NS countries. This group faces a further increase in their TRI, again, because of the loss of bargaining power along their transit routes. More surprisingly, the TRI index rises also for the NS countries. Under this extreme NS-Full Utilization scenario, these countries import too much gas via the NS, decreasing their transit diversification. This scenario turns out to be a bad choice for the NS countries, and one immediate implication here is that the NS-Full Utilization scenario is unlikely to materialize. In turn, this implies that the non-NS countries' losses associated with the introduction of NS may be not so extreme either.

To summarize, the introduction of NS is likely to divide the EU Member States into three groups: The Member States that are not connected to NS, but that share another transit route with the NS countries, would be more exposed to gas import risk; they face a higher TRI whenever NS is used. The Member States served by NS would gain, unless NS is utilized at full capacity. The other Member States buying Russian pipeline gas would not be affected by the launch of the NS pipeline. Finally, full utilization of NS capacity is not very likely, as it will worsen the gas risk situation of both the NS countries and of the Member States sharing older transit routes with them.

4. Extensions

In this section we discuss some potential extensions of our framework.

So far, the paper has analyzed the case of a single gas supplier. However, our approach can be extended directly to consider multiple suppliers. In this case, in line with the conventional approach, the index should account for diversification of supplying countries, gas import dependency and share of gas in total energy consumption of the considered country (see Le Coq and Paltseva (2009) for a related methodology and literature review). Further, similarly to the arguments above, one would need to quantify the transit-associated risks for each of the suppliers.

These considerations would result in the following expression for the Transit Risk Index in case of Multiple suppliers (TRIM):

$$TRI_c^M = \left\{ \sum_{k \in K} \left[\sum_{i_k \in Routes_c^k} \left(\frac{I_c^{i_k}}{I_c^k} \right)^2 RuptRisk_c^{i_k} \times PolRisk_{i_k} \times BP_{i_k} \right] \times \left(\frac{I_c^k}{I_c} \right)^2 \right\} \left(\frac{I_c}{Cons_c^{Gas}} \right) SG_c,$$

where K is the set of all gas suppliers of country c and $k \in K$ is an individual supplier of country c, $Routes_c^k$ is the set of transit routes from the supplier k to country c, and $i_k \in Routes_c^k$ is an individual route to country c, I_c^k are the gas imports from supplier k to country c, $I_c^{i_k}$ are the gas imports from supplier k to country c via transit route i_k, I_c are the total country c's gas imports, and the rest of notations is a natural extension of the ones used in Section 2.

Notice that the above expression for TRI_c^M can be rewritten as:

$$TRI_c^M = \sum_{k = all\_suppliers} TRI_c^k \times \left(\frac{I_c^k}{I_c} \right),$$

where TRI_c^k stands for the Transit Risk Index associated with country c importing gas from supplier k only, as given by formula (1). That is, the index in case of multiple suppliers can be obtained by summing up the TRIs for individual suppliers with weights corresponding to their share of total gas imports and their political risks. This relation further stresses close connection between the single-supplier- and the multiple-supplier cases.

However, the TRIM estimation may be limited by the availability of data. For example, for the EU we failed to obtain complete data on exact transit routes for all gas suppliers. Hence, in Section 3 we chose to focus on risks associated with the EU gas imports from the Russian Federation.

The index can also be extended to reflect increasing integration of the European gas market, for example, through the use of the reverse flow technology. Stronger integration will provide a better opportunity to buffer the short-term supply risks in the exposed countries, which is likely to matter for the importance of the transit risks. To account for this, the index would need to include not only the actual transit routes, but also the ones potentially usable in a case of sudden shortfall. One would also need to control for the sources of such gas swaps, such as national gas storages, etc. While at the moment the use of reverse flow technologies in the EU is very limited, it is likely to become an important factor of security of gas supply in the future.[18]

Another natural extension of our framework would be to address the overall risks of external gas supply. In this paper, we focus on risks associated with pipeline gas imports, in particular transit risks. However, one might also take into account imports of liquefied natural gas (LNG). The transport of LNG does not require a pipeline network, so the issue of transit is less important. For the same reason, LNG is also more fungible than pipeline gas. However, it does require construction of regasification terminals and post-regasification pipeline networks, which often involves large fixed costs. Moreover, LNG is known to be priced higher than is pipeline natural gas. At the moment, the use of LNG in the EU is rather limited: in 2009 LNG constituted 12.7% of total gas supplies (Eurogas (2010)) and in our estimation sample only three countries (Belgium, Italy, and France) import LNG. But the overall share of LNG in the EU's total gas imports is expected to grow, though sources disagree on the extent of this increase (see e.g., Eurogas (2007) and Cala (2008)). Thus, LNG role in the security of the external gas supply will likely increase too.

Our index (at least, its extension to the multiple suppliers case) implicitly accounts for the presence of LNG in a country's gas import portfolio. TRIM includes the share of each pipeline gas supplier in total imports, and so, effectively, the remainder is LNG imports. The diversification of LNG imports is probably not of primary importance, due to LNG's fungibility. However, the political risks of LNG producers, and the LNG market structure (with very few suppliers that are considering forming a cartel) may need to be taken into account. Thereby, the index can be extended to explicitly account for LNG, which may be useful in the future when its role becomes more important.

Another important feature of the gas market is the interaction between the submarkets for pipeline gas, LNG, and non-conventional gas. Changes in supply or demand in one of them, for example due to technological developments or a launch of a new field, would clearly have an impact on the other one. When the index is used to evaluate current or past gas transit risks, this interaction is captured through the observed shares of respective gas sources in the gas import portfolio. However, the use of the index to predict the evolution of gas transit risks would require accounting for the future development in different gas submarkets.

5. Conclusions and policy implications

This paper proposes the Transit Risk Index (TRI), which assesses the riskiness of pipeline gas import, putting a special emphasis on risks associated with gas transit. We evaluate TRI for the gas trade between the EU and Russia. Contrary to a common belief, the EU's risk exposure to the gas deliveries from Russia, as measured by our Transit Risk Index, did not increase over the period 1998–2008. Yet, we find a large dispersion in the gas risk exposure across the EU Member States.

We also show that the introduction of a new transit route, Nord Stream, is likely to further widen the within-EU disparities in risk exposure to the gas supply from Russia. The Member States served by Nord Stream would benefit from the increased route diversification and absence of transit countries, as long as Nord Stream is not utilized at full capacity. At the same time, those Member States not served by Nord Stream, but sharing other Russian gas transit routes with Nord Stream-served countries, are likely to see an increase in their gas risk exposures. These countries would lose bargaining power vis-a-vis Russia, because with the introduction of Nord Stream the older transit routes would constitute a much smaller share of the Russian gas market. Our findings lead us to predict further that Nord Stream is not likely to be run at full capacity, since this level of usage would increase the gas risk exposure of all consuming parties, even the Nord Stream-served Member States.

These factors-the disparities in risk exposure to Russian gas among the EU Member States, the negative impact of a newly introduced pipeline on the Member States not served by it and, more generally, the overall interdependence of national gas markets due to common transit routes-could well make energy security decisions at the EU level very complicated. Recent EU recommendations[19] suggest that supply security measures should be undertaken at the market, national and supranational levels. In particular, two important suggestions are that (1) the EU should identify a common standard of supply security for the Member States, and (2) the response to a crisis situation should be based on a three-level approach, i.e. "involve first the relevant natural gas undertakings and industry, then Member States at national or regional level, and then the Union" (EU Regulation No. 994/2010, p. 4).

We believe that the objective of a common energy policy for the EU has high value and, if properly devised and implemented, a common policy can increase efficiency and reduce costs significantly. Yet, we would argue that the EU recommendations are misspecified. In particular, large variations in gas risk exposure across Member States will make uniform gas security standards difficult to implement, a point raised also by Noël (2010). As for the three-level approach, isolated measures taken at the national level could worsen the position of other Member States, undermining the efficiency of supranational mechanisms to improve gas supply security. Thereby we argue that while gas security measures can be implemented at the national (or/and subnational) level, the overall design and the coordination should be done at the EU level.

Appendix

See Tables A1, A2 and Fig. 5.

[18] See GTE+ Reverse Flow Study TF (2009).

[19] See EU Regulation No 994/2010 concerning measures to safeguard the security of the gas supply and repealing Council Directive 2004/67/EC (2010).

Table A1
Definition of transit routes.

Route	Transit country	Entry node	Countries served by the route
1	Ukraine	Velke Kapušany	Slovakia, Czech Republic, Austria, Germany, Slovenia, Hungary, Italy, France, Belgium, Netherlands
2	Ukraine	Drozdowicze	Poland
3	Ukraine	Beregovo	Hungary
4	Ukraine	Tekovo	Romania
5	Ukraine	Isaccea	Moldova, Romania, Bulgaria, Greece
6	Belarus	Kondratki	Poland, Germany, Belgium , Netherlands
7	Belarus	Kotlovka	Lithuania, Latvia
8		Kometi	Latvia, Lithuania
9	-	Imatra	Finland
10 (Nord Stream)	-	Greifswald	Germany, Belgium, France, Netherlands, Czech Republic[a]

[a] The exact group of countries served by Nord Stream is not yet known.

Table A2
Values of Transit Risk Index (TRI).

Country	TRI					
	1998	2003	2008	2015 projection, alternative scenarios		
				No_NS	NS_Conservative	NS_Full Utilization
Austria	7.4	7.8	7.0	8.3	11.5	14.8
Belgium	–	–	0.8	0.8	0.4	1.0
Bulgaria	11.2	9.7	9.4	8.7	8.7	8.7
Czech Republic	7.6	6.2	6.2	7.1	5.1	5.7
Finland	5.7	6.2	5.3	6.1	6.1	6.1
France	1.8	1.9	1.1	1.2	0.9	1.1
Germany	2.5	3.1	3.1	3.7	2.8	3.9
Greece	2.2	4.8	5.7	6.9	6.9	6.9
Hungary	8.1	12.8	9.4	9.5	12.8	16.1
Italy	4.0	5.2	5.2	5.5	7.6	9.8
Latvia	10.9	14.5	9.6	9.2	9.6	10.0
Lithuania	7.9	11.4	10.8	17.4	18.1	18.7
The Netherlands	–	–	2.8	2.8	1.3	1.7
Poland	4.8	5.0	4.7	5.3	5.6	5.8
Romania	5.6	6.4	4.8	4.8	4.8	4.8
Slovakia	12.9	14.0	11.3	11.7	16.2	20.8
Slovenia	3.6	4.1	2.6	2.8	3.8	4.9

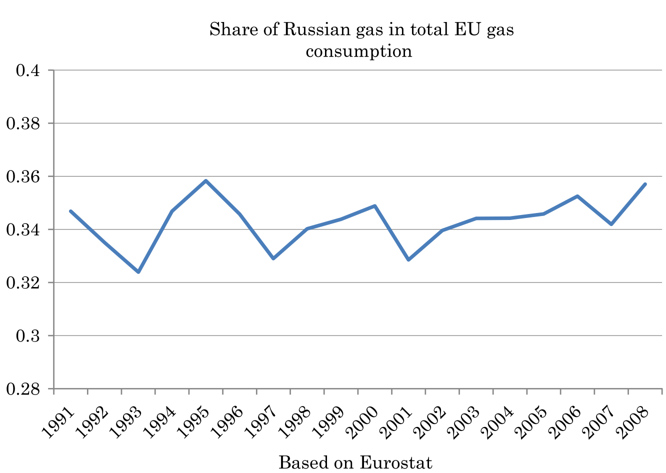


Fig. 5.

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