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ABSTRACT

This paper provides a quantitative analysis of power relations and strategic investment in the transport system for Russian gas. *First, we analyse how the architecture of the transport system determines Russia's bargaining power vis-à-vis (potential) transit countries. By applying the Shapley value as a solution for multilateral bargaining we find that competition between transit countries is of little strategic importance compared to direct Russian access to its customers in Western Europe. Second, we develop a dynamic model of strategic investment. We find that the failure to include Belarus and Ukraine into a framework for international contract enforcement resulted in underinvestment in cheap pipelines and overinvestment in expensive ones. As capacities are increased to gain leverage over transit countries, customers in Western Europe benefit in terms of lower prices and higher supply security.*

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Strategic investment in international gas transport systems

Franz Hubert

1. Introduction

In late 2005, Russia and Germany signed treaties to build a huge new pipeline through the Baltic Sea, the North European Gas Pipeline, which was renamed to *Nord Stream* shortly afterwards.[1] The project will enable Russia to maintain its position as major supplier of natural gas to Western Europe.[2] Plans for an offshore pipeline to Western Europe have been around for quite a while under names like Baltic Ring and North Trans Gas. However, for a long time Russia's western partners dragged their feet, mainly because of all possible ways to increase the transport capacity for natural gas from Russia to Western Europe, *Nord Stream* is the most expensive option (see Figure 1 for an illustration of the network). With *Yamal 1* already in place and the system in the south still in decay, there are commercially more attractive and technologically less demanding alternatives to *Nord Stream*, such as upgrading the old system in the south, adding a second pipeline to *Yamal 1*, and even building new pipelines in the south. However, cost and technological risk are only part of the picture. As the hostile reactions from Ukraine and new EU members Poland, Lithuania, and Latvia suggest, *Nord Stream* will alter the balance of power in the region. It will also have a long-term impact on the EU's ability to formulate a common energy policy.

Production and transportation of natural gas are characterised by large initial investment in specialised facilities with a long lifetime and low operating costs. Most of the expenditures on project identification, investment planning, and construction are sunk. Once installed, capacities generate large quasi-rents. Hence, it is essential that the countries can credibly commit to grant access to pipelines on agreed terms. Currently, there are no international institutions that could enforce multilateral contracts in case of a dispute if countries outside the EU are involved. If some countries cannot commit *ex ante* to share the rents in long-term contracts, re-contracting after completion of the investment is anticipated. As a result, investment may be distorted to gain leverage in the bargaining process. This distortion may lead to underinvestment in cheap pipelines and/or overinvestment in expensive ones – compared to what would maximise the profits of the supply chain for Russian gas. Given its very substantial markets share, Russia enjoys some market power *vis-à-vis* European customers. Hence, underinvestment tends to increase prices for European customers while overinvestment decreases them. As a result, conflicts along the vertical supply chain have an impact on customers in the West far beyond the rare short-term interruptions that usually attract much public attention.

This paper summarises previous work by Hubert and Ikonnikova (2003), Hubert and Ikonnikova (2004) and Hubert and Suleymanova (2006). In this literature, the interdependencies among the players are captured by a game in value-function form. The 'power' of a player is measured by the Shapley value of this game. A major advantage of this approach is that it does not involve *a priori* assumptions on bargaining power or details of the bargaining process, about which little is known. Instead, it derives the power structure entirely from the geography of the network and the cost differentials between the various pipelines. The value function can be used to model different institutional structures.

1 For ease of reference, we use *italics* for those pipelines that are explicitly shown in the Figures below and/or form part of the model developed in this paper.

2 Throughout this paper we will refer to 'Western Europe' as the market consisting of the EU-15 countries excluding Greece. For ease of reference, we use the names of the countries instead of companies when there is no risk of confusion. Hence, we speak of Russia rather than Gazprom, Ukraine instead of Naftogaz, and so on.

For the Eurasian pipeline system we can quantify the cost of the different pipeline options with reasonable accuracy to calibrate the model and predict the impact of transport capacities on the power structure. This, in turn, allows us to calculate how the players would optimally invest under various assumptions about their ability to make long-term commitments. We consider a 'strategic' investment a player's attempt to influence the power structure – formally: the Shapley value – to its advantage. The resulting investment pattern deviates considerably from 'non-strategic' investment, which would maximise the profits of all players and minimise transportation cost for any given total capacity. The difference between the two is also called the strategic distortion of investment.

In spite of many unresolved conflicts between Russia and gas transit countries, the flow of gas has been interrupted only on two occasions.

In spite of many unresolved conflicts between Russia and transit countries, the flow of gas has been interrupted only on two occasions. During such a crisis, observers tend to focus on the immediate impact of actions. From this shortsighted perspective the power of a player is determined by its control of existing transport capacities. The *status quo*, however, can be changed by adding new pipelines to the existing system. In principle, rational, farsighted players should, therefore, take into account all relevant options to modify the network to obtain a comprehensive assessment of their relative bargaining power.

As a first step, we consider the two borderline cases of shortsightedness and farsightedness to obtain reasonable bounds on what we may expect from a dynamic analysis. By comparing the two scenarios we are also able to assess the strategic relevance of different pipeline options. Our quantitative analysis reveals that some commercially feeble projects are, nevertheless, very important for strategic reasons. Others, which have been deliberately drawn up to alter the balance of power, turn out to be strategically irrelevant.

As a second step, we develop a truly dynamic analysis for a stripped-down version of the model. In every period, the players bargain on the sharing of rents from previous investment. At the same time, however, they can form coalitions for new investment. Additional transport capacities have a long-lasting impact on bargaining power, but they become available only with some delay. In this dynamic, infinite horizon setup, we investigate the incentives for strategically distorting investment.

As in Hubert and Ikonnikova (2004), the distinction between short-term and long-term cooperation is crucial. Short-term cooperation refers to the coordinated use of the existing transport capacities in any given period. It also includes the sharing of current profits if this has not been determined previously in a long-term agreement. Long-term cooperation revolves around the joint determination of transport capacities, ownership or secured access rights, and long-term rent sharing. It requires commitment over time spans of up to forty years. In principal, these commitments can be based on contracts that are enforced by external institutions. If these institutions are not available, long-term cooperation can also be based on dynamic strategies, which support cooperation by the mutual threat of retaliation. In the literature on cartels this informal cooperation is often called collusion.

Our quantitative analysis shows that strategic considerations are of outmost importance in the Eurasian transport network. If the players fail to collude and invest non-cooperatively, all equilibria feature substantial overinvestment to create countervailing power. While cheap investment opportunities are neglected, new expensive pipelines are built, with capacities well ahead of the development of demand. As a result, prices for customers will be lower than if the members of the supply chain for Russian gas would coordinate to maximise their joint payoff. Not surprisingly, there is a large potential for raising profits through dynamic collusion. However, the members of the supply chain largely failed to realise this potential.

The remainder of this paper proceeds as follows. The next section sets the stage by briefly describing the pipeline system for transporting natural gas to Western Europe. Section 3 and 4, respectively, present the static analysis of bargaining power and the dynamic analysis of strategic investment. Section 5 concludes.

2. The supply chain for Eurasian gas

2.1 The current gas transport network

Currently, natural gas has a share of about 25 percent in the fuel mix of the energy consumption of the European Union. This share is likely to grow in the near future, because gas is considered to be an environmentally less harmful source of energy than coal and oil. In 2005, about a quarter of the gas consumption was covered by supplies from Russia, though the share is much larger for France (28 percent), Germany (35 percent), Austria (55 percent), and Poland (53 percent). The magnitude of gas imports from Russia creates concerns of energy dependency and reliability of supplies.

Dependency on Russian gas is difficult to avoid, given that the only alternative producers of pipeline gas, Norway and Algeria, are not able or likely to substantially increase production.[3] However, it is worth stressing that the dependency is mutual. It is often emphasised that Russia honoured contracts in the past and did not abuse its position for political purposes. Hence, reliability refers mainly to the problem of secure transport through transit countries, with which both Russia and the EU failed to establish solid and stable political and economic relations.

Russian natural gas is delivered through a network of pipelines stretching from the industrial centres in Western Europe to the main pipelines in western Russia and further on to fields in permafrost regions of Siberia and the steppes of central Asia. The main features of the transport system have been shaped during the 1970s and 1980s. When the Soviet Union started to supply gas to Western Europe in the late 1960s, it extended an existing pipeline – through which gas was transported from eastern Ukraine to Czechoslovakia – to connect to Austria and Germany. This connection is part of what is called the *Southern System* in Figure 1. As exports increased, additional capacities were established alongside previous routes, which were linked to new fields in the southern Ural (Orenburg). Surprisingly, even when production shifted northwards to Vuktylskoe and fields in western Siberia, the pipelines exporting this gas to the west took a turn towards the old routes in the south. Plans to build a new pipeline through Poland and former East Germany were abandoned, apparently because the Soviets considered occupied Czechoslovakia, through which the southern track went, to be politically more reliable.

When the Soviet Union collapsed, however, Russia found itself in the uncomfortable position that its only supply route to Western Europe passed through three newly independent states: Slovakia, the Czech Republic, and Ukraine.[4] Looking westward towards integration with the EU, Slovakia and the Czech Republic privatised their pipelines, which were acquired by western importers. The transition to stable commercial gas relations was also eased by both countries' entitlements to large gas deliveries at low cost, inherited from former Czechoslovakia.

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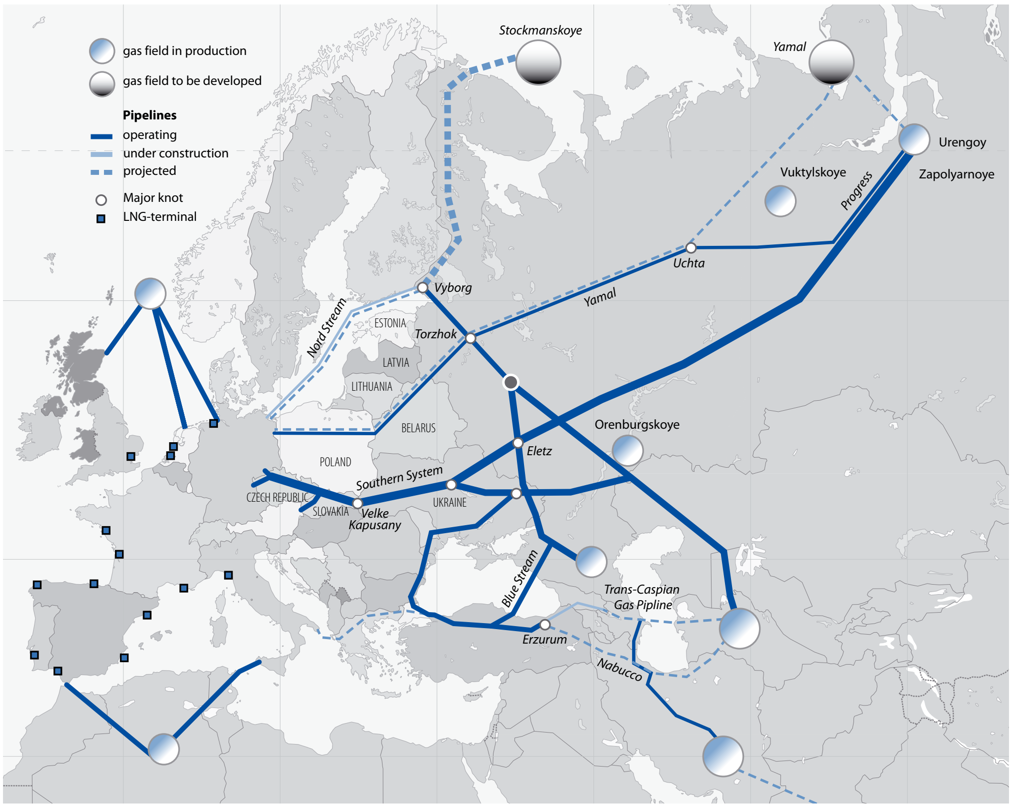
3 The picture may change if the pipeline *Nabucco* directs Iranian and Turkmen gas to Europe, but this project is doubtful for political reasons and not considered in this paper.

4 For detailed and balanced accounts of the ensuing conflicts and Russia's strategy see Stern (1999) and Stern (2005).

Figure 1. Eurasian gas transport network



For many years, Russia and Ukraine failed to find a lasting solution for their gas relationship.

Russia and Ukraine, in contrast, failed to find a lasting solution for their gas relationship. In principle, Russia paid for transit by supplying gas to Ukraine, approximately 26-30 billion cubic metres a year (bcm/a). This payment in kind is sometimes translated into a 'transit fee' by assigning a price to the gas, but as these fees are not actually paid, they have little relevance. The conflicts are essentially over the compensation for additional 25 bcm/a, which Ukraine dearly needs. While Russia claimed average European prices, Ukraine conceded only half of that. In the late 1990s, even the lower figures were not fully paid. Ukraine has also been blamed for syphoning off gas in excess of what it acknowledges officially, a claim that has some credibility, although it is strongly denied by Ukraine.

As a result of non-payments and alleged 'stealing', debts accumulated. In 2002, these amounted to $1.4bn or $3.5bn – depending on which side one takes. As a partial solution Ukraine paid $285m by handing over strategic bombers and missiles in 2002/2003, but both sides could not agree on prices of other components of the proposed barter deal. Meanwhile, due to aging compressors, lack of maintenance, and underinvestment, the capacity of the transport network declined.

In mid-2004, Gazprom and Ukrainian Neftogas apparently reached a comprehensive solution for their long-standing conflict. The agreement converted controversial debt into a formal loan and established a new barter agreement for the use of the transport facilities. Under this agreement, Gazprom was expected to deliver 21-25 bcm/a for the period 2005-09.[5] A Russian-Ukrainian consortium RosUkrEnergo was set up to operate and refurbish the Ukrainian transit system in cooperation with Western partners. By replacing old compressors, the transport capacity could

5 The nominal price for transport was set at $1.094/tcm/100km, which is fairly standard. The implied price for gas was set at $50/tcm – about a third of the Western European price at that time (tcm = thousand cubic metres).

have been easily increased by 15 bcm/a. A further expansion still benefits from the established infrastructure but requires complementary investment in pipelines, in particular in Slovakia and the Czech Republic.

However, Ukraine failed to transfer the pipeline system to the consortium. After the Orange Revolution brought a regime change in December 2004, the other parts of the deal quickly unravelled. The new government questioned the debt settlement and opened criminal investigations against RosUkrEnergo, which was declared a failure in summer 2005. The mysterious disappearance of 7.8 bcm from Gazprom's storages in the Ukraine further strained the relation. With gas prices soaring to a record $230/tcm in Western Europe by late-2005, both sides were still haggling over conditions for deliveries in 2006. Russia insisted on international prices while Ukraine offered a third of that amount. With no contract in place, the crisis culminated in January 2006, when Russia shut down deliveries earmarked for Ukraine. However, Ukraine simply continued to take from the export pipelines whatever it needed, and Russia had little choice but to make up for Ukraine's diversions or to default on its obligations to western importers. It took only four days, to find a formal solution to the dispute, but a comprehensive contract was signed only after lengthy negotiations with a new government in Kiev.

Let us then consider how the gas transport network has been extended so far since the break-up of the Soviet Union. After gaining independence, Belarus' ties with Russia remained initially very close. In 1993, both countries agreed on a long-term solution for sales and transit relationships, including the transfer of transit routes from BelTransGaz, the national transmission company, to Gazprom under a 99-year lease. In the case of Poland, a joint stock company, EuroPolGaz, was established in which Polish PGNiG and Russian Gazprom hold equal shares. This encouraged Gazprom to revive old, ambitious plans to develop the huge Yamal field and connect it to internal and external markets with a new massive northern route. However, as demand was weak during the 1990s and the cost of developing the Yamal field turned out to be very high, the project was gradually scaled down. Eventually, attention focussed entirely on the export pipeline, now commonly referred to as *Yamal 1*, which is built 'from the market to the field'.[6] The first pipeline went into operation in 1998. Due to delayed investment in compressor stations, it did not reach its capacity of 28 bcm/a before 2006. A second pipeline, *Yamal 2*, with a potential of another 28 bcm/a has already been laid at major river crossings (see Victor and Victor 2006).

Like Ukraine, Belarus seeks large price concessions for its gas imports using the leverage it gains from its strategic position in the export chain.

After *Yamal 1* started to pump gas, relations between Russia and Belarus deteriorated. Like Ukraine, Belarus seeks large price concessions for its gas imports using the leverage it gains from its strategic position in the export chain. In April 2002, a deal was reached under which Gazprom had to deliver 10 bcm/a at a discount price and accumulated debts were swapped for a controlling stake in BelTransGaz, which manages Gazprom's pipelines in Belarus. However, the second part of the deal, which would have given Gazprom a much more effective control over its export routes, never materialised. When negotiations about new conditions for gas supplies failed, Gazprom stopped deliveries to Belarus at the end of 2003. For a couple of weeks, independent suppliers filled the gap at higher prices, and then Belarus started to divert gas from the export pipeline. Gazprom responded by shutting down gas supplies altogether, deliberately cutting off not only Belarus but also Kaliningrad, Poland, and Germany in February 2004. The immediate crisis was resolved within one day, avoiding any serious impact on customers in the West. Then it took both countries almost five month to agree on a temporary solution until the end of 2006. Formally, Belarus bowed to Russian

6 At that time, the high cost of developing new fields such as Yamal or Shtokman and the availability of low-cost alternatives in old Siberian fields and Turkmenistan cast doubt on the economic viability of grand-scale projects in the near future (Stern 1995). Meanwhile, gas for *Yamal 1* is supplied from fields in the Siberian Basin including newly opened Zapolyarnoye.

demands for higher gas prices, but the net impact was small because Belarus was compensated by an increase in transit fees. In December 2006, both countries found themselves again at the brink of a crisis. The new 5-years supply and transit contract was not signed before late at night on December 31. It raised prices for Belarus from about a quarter of Western European levels to half of that and envisaged a stepwise adjustment to international prices by 2011. What looks like a very substantial price increase is at least partly compensated for by a doubling of transit fees for gas shipped to Poland and by cash payments Gazprom is expected to make for a gradual acquisition of BelTransGaz, Belarus' national gas company. The latter, if fully executed, would give Gazprom a controlling stake by June 2010 (see Yafimava and Stern 2007 for details). In view of Belarus' reluctance to cede control on previous occasions, we see a chance that it may fail to implement the last step. In the meantime, Gazprom's payments would mainly offset the price increase.

2.2 Alternative options for extending the gas transport network

A salient feature of some network extensions is that they would bypass some – or even all – of the current gas transit countries.

A salient feature of the possible network extensions we consider now is that they would bypass some – or even all – of the current transit countries. As a direct threat to Ukraine's strategic position, Russia developed plans for a twin pipeline with a capacity of 60 bcm/a running north-south through Belarus, Poland and Slovakia.[7] Since this link can also be seen as part of the larger Yamal project, it is sometimes referred to as *Yamal 2* (with a planned capacity of 28 bcm/a). However, if realised without additional investment towards customers in the West (and fields in the east) it would mainly serve to bypass Ukraine, hence, we will refer to this project as *Bypass* (see Figure 2). With an estimated cost of €4bn, the *Bypass* has limited commercial value in a narrow sense, because it does little to increase transmission capacities westwards. Nevertheless, offering an alternative to the route through Ukraine, its strategic value is potentially large.

In principle, Belarus can also be bypassed through Latvia and Lithuania, an option to which we will refer to as *Baltic* (see Figure 2). Standing alone, such a pipeline would allow using existing capacities of *Yamal 1* in Poland and Russia without involving Belarus. Beyond the capacity of *Yamal 1*, the same track could be part of a revised *Yamal 2* project. So far, this possibility has attracted little public attention, but it may explain the hostile reaction of the Baltic states towards the announcement of another pipeline even further to the north, to which we turn next.

Early plans for a Baltic Ring, connecting Russia through Finland and Sweden to Germany have been abandoned during the late 1990s in favour of a direct offshore connection between Vybourg (Russia) and Germany called North Trans Gas. Initially, Gazprom and Fortum – a Finnish energy company – shared the project, but German Ruhrgas and Wintershall were subsequently invited to join. Planned capacities ranged from 18 bcm/a to 30 bcm/a. Commercially, the link would have looked more attractive if connected to Shtokman, a large field yet to be developed. As with Yamal, the prospects for the development of Shtokman are vague at best. And even if the field is developed, it might be cheaper to liquefy the gas, since the costs of an onshore pipeline appear to be very high due to difficult terrain on the Kola Peninsula. Nevertheless, Russia kept pushing North Trans Gas in international negotiations, while Western partners dragged their feet due to high cost.[8]

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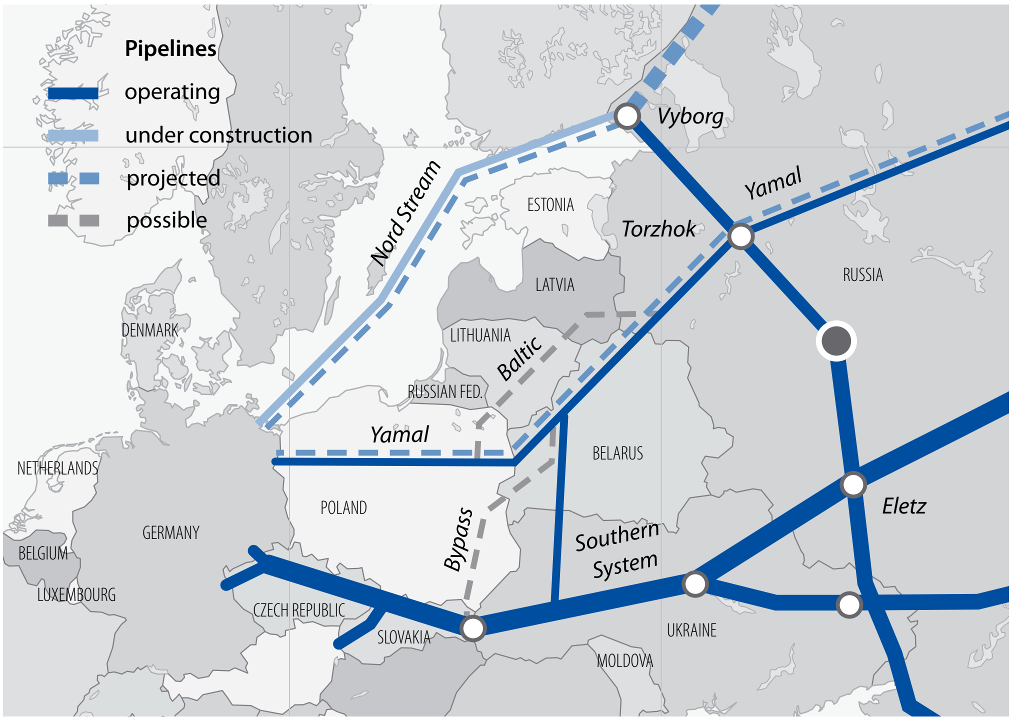
7 Gazprom would be in charge of the section in Belarus. For Poland and Slovakia, a consortium was set up including among others Gazprom (18 percent), PGNiG (10 percent), SNAM (29 percent), Ruhrgas (22 percent), GdF (12 percent), and Wintershall (5 percent). The project was pushed in the late 1990s but never got off the ground. Apparently it was shelved with the agreement between Russia and Ukraine in 2003.

8 In the south, another off-shore project, the *Blue Stream* pipeline (see Figure 1) through the Black Sea to Turkey, started operations in 2002 under a long-term agreement with Turkish Botag. It substitutes for pipelines running through Ukraine, Moldavia, Romania, and Bulgaria – where conflicts have been similar to those on the east-west routes.

In 2005, the project took a surprising turn. Under the name North European Gas Pipeline, now called *Nord Stream*, a German-Russian consortium – involving E.ON-Ruhrgas and Wintershall – announced the construction of a twin pipeline with a capacity of 60 bcm/a. Understanding that the project will shift the balance of power in the transport system for natural gas, the announcement triggered a very hostile reaction, in particular from the Baltic states and Poland, which tried to muster their influence as EU members to lobby against the deal. But in spite of this opposition, construction work on the Russian on-shore section started soon after the announcement.

Figure 2. Options for extending the Eurasian gas transport network



3. Static analysis: pipelines and bargaining power

3.1 Modelling bargaining power

In this section, we develop a formal model of the supply chain, from which we can derive quantitative results. As countries control only sections of the pipelines, they have to cooperate in order to generate revenues. The interdependencies among the players are represented by the so-called value function, which assigns a payoff, or value, to every possible subset of players. From the value function we can calculate the marginal contributions of any player to any subset of other players. It indicates how much the group can gain by incorporating the player. Hence, a player's marginal contribution reflects the value of his pipelines, or more generally resources, for others. Intuitively, the more important a player is for others, the more power he has and the larger his share of the profits will be. This intuition is nicely captured by the so-called Shapley value (see Box 1 for details). The Shapley value of a player is calculated by taking the weighted average of his marginal contributions. The weights are given by the probability that a subset of players is formed when the players are ordered at random. Hence, the Shapley value can also be interpreted as the expected marginal contribution of a player under random ordering bargaining.

The more important a country is for others in a multilateral bargaining situation, the more power it has and the larger will be its profit share.

The main players in the network are Russia, Ukraine, Poland, and Belarus. In addition we include Slovakia, Latvia, and Lithuania, which are involved in attempts to bypass Ukraine or Belarus.

As to pipelines, we strife for a fairly comprehensive picture, taking into consideration the old system through Ukraine, which we will refer to as *South*, the possibility to *Upgrade* it, the current *Yamal 1,* its possible enlargement *Yamal 2*, *Bypass*, *Baltic*, and finally *Nord Stream*. However, a player's command over resources also depends on institutional features. For this reason we will not consider the sections of the *Southern System* located in Slovakia and the Czech Republic. They have been sold to importers and cannot be used as a bargaining chip without violating EU laws. We also assume that Poland, as an EU member, cannot obstruct the use of the existing pipeline *Yamal 1*. Poland is bound by long-term agreements, which effectively give Russia assured access to *Yamal 1*. However, like Slovakia, it can veto any new pipeline on its territory. Hence, without Poland, neither *Baltic* nor *Yamal 2* can be built.

The Shapley value describes the contribution of each participant to the overall operation, and the payoff he can reasonably expect.

Box 1. Shapley value

Strategic interdependencies are represented by a game with N players and value function $v(S)$ for all coalitions $S \subseteq N$. The marginal contribution of player $i \in N$ to a coalition $S \subset N$ is given as $v(S \cup i)$ - $v(S)$. The Shapley (Shapley 1953) value solves the game (N, v) by assigning each player i a payoff φ_i , which is equal to his expected contribution to all possible coalitions, assuming that coalitions are formed by adding players at random. It is calculated as

$$\varphi_i = \sum_{S:i \notin S} \frac{|S|!(|N|-|S|-1)!}{|N|!}[v(S \cup i) - v(S)].$$

The Shapley value has a number of desirable features. First, it is unique and always exists. Second, it is the unique solution to the game (N, v), which simultaneously fulfils reasonable criteria such as: the total payoff is distributed (efficiency); interchangeable players receive the same payoff (symmetry); players that contribute nothing to all coalitions receive nothing (dummy player condition); and if one combines coalition games described by different value functions, the players' payoffs of the combined game equal their combined payoffs of the original games (additivity). The last two properties can be replaced with the following (monotonicity): if a player's contribution to all coalitions weakly increases, then his payoff should not decrease (Young 1985). Finally, it is the unique solution featuring balanced contributions, that is, for any two players $i, j \in N$ it is true that i loses as much when j leaves the game as j loses when i leaves the game (Myerson 1980). Hence, if a player objects the Shapley allocation by pointing out the damage he can impose on another player through a boycott of cooperation, his opponent can always counter the argument.

3.2 Calibrating the model

The model is calibrated by calculating the value function for every possible coalition of players. There is considerable uncertainty as to an appropriate estimation of the demand for Russian gas and the cost of producing it in the gas fields of western Siberia.[9] However, these assumptions affect all coalitions in a similar way and have little effect on the relative bargaining power. We use a simple linear function and choose parameters so as to reflect the situation around 2000 and to make existing capacities sufficient (see Hubert and Ikonnikova 2003 for details). Hence, a grand coalition

9 We use a simple linear schedule for the residual demand for Russian gas. Russia cannot raise the price in the short run given its contractual obligations. In the long run, it faces competition from gas suppliers like Norway and Algeria, LNG and other energy sources. Hence, we have opted for a rather flat demand schedule, implying a fairly high price elasticity at current quantities. Our results on the power structure are fairly robust to changes in the elasticity of demand.

of all players would maximise its profit by using the existing capacity of *South* (70 bcm/a) and *Yamal 1* (28 bcm/a), both of which are available at low operating cost. Any additional capacity requires new investment. Up to a limit of about 15 bcm/a, the cheapest option would be *Upgrade*. By modernising compressor stations, the capacity of existing pipelines in Ukraine can be increased at low cost. Beyond that limit, investment in new pipelines is required, for which capital cost are at least twice as high. As for new pipelines, *Yamal 2* is slightly more efficient than further extensions in the south. By far the most expensive option is *Nord Stream*, which requires at least yet another doubling of capital expenditures per unit of capacity. Using this calibration we can calculate how different sub-coalitions would use and extend the system to maximise their payoff.

A grand coalition of all players would maximise profits.

The main results are reported in Table 1. The first column shows the smallest coalition necessary to implement the transport network characterised in the next seven columns. The figures indicate for all pipelines their availability and capacity: "-" means that this link is not available to the coalition, "0" indicates that a link is available, but the coalition chooses not to install capacities. Positive figures indicate usage of existing or investment in new capacities. The last three columns show the resulting price for gas and the payoff, or value, of the coalition. We report the absolute payoff (in million euros) and the relative payoff (in percent), that is, the absolute payoff of a particular coalition relative to the payoff a grand coalition of all players could achieve. In what follows, we will focus on relative payoffs, which largely reflect geography and differences in transportation cost.[10]

Table 1. Coalitions, capacities, prices, and payoffs

Coalition	Pipeline capacity (bcm/a)							Gas price (€/tcm)	Payoff (€ million)	Payoff (% of all players)
	South	South Upgrade	Yamal 1	Yamal 2	Bypass	Baltic	Nord Stream			
R	-	-	-	-	-	-	72	136	3,976	57
R, U	70	15	-	-	-	-	0	132	6,728	96
R, B	-	-	28	-	-	-	45	136	5,039	72
R, B, P	-	-	28	60	-	-	0	131	6,216	89
R, B, U	70	0	28	-	-	-	0	128	6,979	100
R, B, P, S	-	-	28	0	60	-	0	131	6,524	93
R, Li, La	-	-	-	-	-	28	45	136	4,785	69
R, P, Li, La	-	-	-	0	-	88	0	131	5,962	85
All players	70	0	28	0	0	0	0	128	6,979	100

Note: R ≡ Russia, B ≡ Belarus, P ≡ Poland; U ≡ Ukraine; S ≡ Slovakia; La ≡ Latvia Li ≡ Lithuania

On its own, Russia would choose *Nord Stream*, the only pipeline option for which Russia does not need to form a coalition, and install a capacity of 72 bcm/a. This would give Russia an annual payoff of around €4bn, which is equal to 57 percent of the profit of a grand coalition. Russia and Ukraine together would forgo investment in *Nord Stream* and invest in *Upgrade* (that is, the upgrading of the existing *Southern System*). By avoiding the large cost of *Nord Stream* this coalition would achieve a relative payoff of 96 percent. Given that Russia's access to the Polish section of *Yamal 1* is secured by assumption, the coalition of Russia and Belarus would use the existing 28 bcm/a on *Yamal 1* and install a capacity of 45 bcm/a at *Nord Stream*, thereby earning a relative value of 72 percent. If Poland joined that coalition, investment would shift from *Nord Stream* to *Yamal 2*, with a capacity of

10 By contrast, absolute payoffs are sensitive to our assumptions about demand and production costs. Although not shown in Table 1, most coalitions either have equivalent investment opportunities, hence payoffs, or cannot establish a complete supply link and have zero profit. For more details see Hubert and Ikonnikova (2003).

A coalition of Russia, Belarus, and Ukraine would achieve the profits of the grand coalition.

60 bcm/a, yielding a payoff of 89 percent. Not too surprisingly, the coalition of the three major players (namely, Russia, Belarus, and Ukraine) would achieve the value of the grand coalition simply by using the existing capacities.

The *Bypass* would enable Belarus, Poland, and Slovakia to replace the most important transit country, Ukraine, using existing capacities through Slovakia and the Czech Republic. By including Slovakia, the coalition *{R,B,P}* could increase its payoff by 4 percentage points to 93 percent. The difference is modest, but it requires only one additional player. *Baltic* – that is, the link through the Baltic countries – would allow Latvia and Lithuania to replace Belarus in using *Yamal 1* and build a variant of *Yamal 2*. These options would enable the coalition *{R,P,Li,La}* to achieve a payoff of 85 percent. Compared to what Russia can achieve alone, this is an increase of 28 percentage points. The difference is large, but it takes three additional players to achieve it.

3.3 The power structure

In Table 2 we present the players' relative power, as calculated from their Shapley values for various assumptions over the availability of pipeline connections. Since demand for gas and production cost have been chosen to be compatible with current transport capacities, there would be no commercial interest to increase capacity beyond *South* and *Yamal 1*. The available options for investment would not be used. Nevertheless, they have an impact on the power of the players, hence the sharing of profits. Before explaining the details, it is worth mentioning that while we measure the power of a country by its share in total profit from the gas export business, a literal interpretation would be too narrow. Given the complexity of the relations between the countries, it is reasonable to assume that some countries receive their 'share' not in the form of money, but as political concessions on other issues.

Table 2. Countries' profit share (in percent) for alternative pipeline options

	Status quo	Adding one option at a time				
		South Upgrade	Yamal 2	Bypass	Baltic	Nord Stream
Russia	57.1	57.8	60.3	59.2	58.7	79.7
Ukraine	31.8	32.5	22.2	23.2	29.1	15.1
Belarus	11.1	9.6	14.3	13.2	7.5	5.2
Poland	0.0	0.0	3.2	2.1	1.6	0.0
Slovakia	0.0	0.0	0.0	2.1	0.0	0.0
Lithuania	0.0	0.0	0.0	0.0	1.6	0.0
Latvia	0.0	0.0	0.0	0.0	1.6	0.0
	All options	Excluding one option at a time				
		South Upgrade	Yamal 2	Bypass	Baltic	Nord Stream
Russia	82.5	82.0	82.0	82.3	82.1	62.7
Ukraine	9.8	9.2	10.6	10.7	10.7	19.2
Belarus	4.3	5.1	3.8	4.1	5.4	10.1
Poland	2.1	2.3	1.6	1.9	1.6	4.9
Slovakia	0.2	0.2	1.1	0.0	0.2	0.2
Lithuania	0.5	0.6	0.5	0.5	0.0	1.4
Latvia	0.5	0.6	0.5	0.5	0.0	1.4

Notes: To recall, the *status quo* is characterised by capacities of 70 bcm/a at *South* and 28 bcm/a at *Yamal 1*. Demand for gas and production cost have been chosen so that these capacities are sufficient and optimal for meeting demand, yielding a total annual profit of €6.979bn, or 100 percent. Figures may not add up due to rounding.

The first column under the heading 'status quo' reports the shares for a situation where the currently existing network cannot be changed, i.e., no new pipelines or upgrading of existing capacity are possible. This corresponds to the shortsighted view on relative power. To interpret the figures, consider the hypothetical situation where all pipelines were to run through Ukraine. In such a bilateral monopoly, Russia and Ukraine would each get 50 percent of the overall profit. With *Yamal 1* in place, however, Ukraine's share is down to 32 percent, while Belarus gains 11 percentage points.[11] However, as the capacity at *South* could not fully replace *Yamal 1* (and *vice versa*), competition between Ukraine and Belarus remains limited. As a result Russia, gains only 7 percentage points compared to a hypothetical bilateral monopoly comprising Russia and Ukraine.

If we adopt the farsighted view of power structure by taking into account the various possibilities to change the transport grid, the picture changes dramatically. The results are reported under the 'all options' heading in the lower part of Table 2. With almost 83 percent, Russia now obtains the lion's share of the profit. Recall that, given our assumption on demand and supply, none of the additional options would materialise. It is the mere possibility to build pipelines – through the Baltic Sea, to increase capacities on *Yamal* and on *South*, or to bypass Ukraine and Belarus – that increases Russia's share by more than a quarter of the total payoff. Given its strength in the current system, it is not surprising that Ukraine's power index suffers most. It is slashed by two thirds, from 32 percent down to 10 percent. With a loss of 7 percentage points, Belarus is also hard hit.

Given their current importance as gas transit countries, Belarus and Ukraine lose most from gas network extensions that can be implemented without them.

The smaller countries – Latvia, Lithuania, and Slovakia – derive their power from making it possible to bypass Belarus and Ukraine. Their payoffs are tiny compared to those of the established transit countries. However, given their much smaller population, the benefits are still very substantial. If measured in per capita terms, the benefits for Lithuania and Latvia fall in between Poland and Ukraine, which may explain their very active lobbying against *Nord Stream*.

3.4 The strategic value of alternative pipeline options

To single out the strategic value of a particular option, we assess its impact on the power structure. One way of doing this is to add one link at a time to the 'status quo' (upper part of Table 2). Alternatively, we can evaluate the strategic value of a particular option in the context of other options by withdrawing one link at a time from the benchmark case 'all options' (lower part of Table 2).

For small additions to the capacity, *Upgrade* is the cheapest, hence, commercially most interesting option. Given that the additional capacity is limited (15 bcm/a), its impact on power is small, whether it is evaluated relative to the status quo or in the context of all other options.

If *Yamal 2* were the only possibility to increase capacity, its strategic impact would be substantial. Adding it to the status quo would cut Ukraine's profit share by more than 9 percentage points. If seen in the context of the other options, however, the impact of *Yamal 2* is small. Comparing the third column to the first in the lower part of Table 2 shows that with *Yamal 2* coming on top of all other options, Russia, Belarus, and Poland would each gain half a percentage point, while Ukraine and Slovakia would lose 0.8 percentage points and 0.5 percentage points, respectively. Slovakia's loss indicates that the strategic value of *Yamal 2* is related to *Bypass*, the only pipeline that requires the involvement of this country.

11 Recall that by assumption Poland cannot obstruct the use of *Yamal 1*, hence it cannot derive any power from threatening to do so. However, in negotiations before the pipeline was built, it had secured a share, which is not accounted for in our model.

Like *Yamal 2*, *Bypass* is important only if it is the sole addition to the status quo. Assessed in the context of all other options, however, its impact on Russia is negligible – and even Slovakia gains very little. This is because all coalitions that can realise *Bypass* (that is, *{R,B,P,S}* and the coalition of all players) can also realise *Yamal 2*, which is just marginally less profitable.

Considering *Baltic,* which inculdes a variation of *Yamal 2* that could be realised without Belarus, we find that Poland, Latvia, Lithuania, and Russia would each gain 1.6 percentage points if *Baltic* were to happen as the only addition to the status quo. These gains would come at the expense of Ukraine and, not surprisingly, Belarus. Examining *Baltic* in the context of all other options shows that it would add around half a percentage point to the profit share of Poland, Latvia, Lithuania, and Russia. As for Russia, this change is marginal. But as argued above, for small countries, like Latvia and Lithuania, the benefits of even a small share in profits are substantial.

By far the strongest impact on the power structure comes from Nord Stream.

By far the strongest impact on the power structure comes from *Nord Stream*. In isolation, it raises Russia's claim on profits from 57 percent to 80 percent. Even when assessed in the context of all other options, *Nord Stream* raises Russia's share from 63 percent to almost 83 percent. It is more important than all other options together. Correspondingly we observe a considerable decline in the bargaining power of Ukraine, Belarus, Poland, Lithuania, and Latvia – as indicated by the sharp change in their profit shares. Only Slovakia remains unaffected. The strategic importance of *Nord Stream* explains Russia's continued interest in a project that from a naïve point of view makes little economic sense due to its high cost.

3.5 The role of geography and cost

To further develop the intuition for the numerical results, it is useful to consider how geography and cost interact in determining bargaining power. For simplicity, we consider only four main countries: Russia, Belarus, Poland, and Ukraine. To isolate the role of geography, suppose gas transport costs are the same for all pipelines, so that total profit is the same whatever pipeline is used. If the only possible transport route was through Ukraine, Russia and Ukraine would each get half of the profit. If we add an equally efficient route through Belarus and Poland, Russia would obtain 7/12 of the profit, Ukraine 1/4, and Belarus and Poland would share the rest equally, obtaining 1/12 each.[12] Ukraine thus suffers a lot from the competing route, but Russia has to share the gain with the other two transit countries. Finally, if Russia establishes a direct offshore link on its own, it obtains the whole profit, as there is no need to share with anyone.

Now, assume that all options are available, but pipelines differ in their cost, either because of different conditions (offshore *vs*. onshore) or because investment costs are already sunk as in the case of *South* and *Yamal 1*. Loosely speaking, Russia would start with the profit it would get if *Nord Stream* were the only connection to Western Europe. While *Nord Stream* looks inefficient compared to options such as *Upgrade* and *Yamal 2*, standing alone, it would be a highly profitable project. Given our calibration, it already yields 57 percent of the profit of the most efficient transportation network – that is, the network resulting from a coalition of all players.[13] In addition, Russia will obtain 7/12 of the increase in profit obtained from switching from the offshore to the next best onshore option, *Yamal*, which increases profits to 89 percent. Finally, Russia would enjoy 1/2 of the increment achieved from using the most efficient solution, which includes the system in the south. Summing

12 With payoffs normalised to one, the value function would be: $\pi(R, B, P) = \pi(R, U) = \pi(R, P, U) = \pi(R, B, U) = \pi(R, B, P, U) = 1$ and zero in all other cases, yielding Shapley values of $\varphi_R = 7/12$, $\varphi_B = \varphi_P = 1/12$, and $\varphi_U = 1/4$.

13 These payoffs are again taken from Table 1.

up, Russia's profit share would amount to 81 percent.[14] Hence, we obtain almost the same figure as the one following from the more complex model reported in Table 2. Enriching the analysis with more players and pipeline options adds to its realism, but the quantitative results change only marginally.

4. Dynamic analysis: hold up, strategic investment, and dynamic cooperation

4.1 Dynamic cooperation in the absence of legally enforceable agreements

So far, we have developed a method for analysing the relation between network architecture and power and explored the strategic relevance of pipeline options. However, provided that all participants understand this relation, there would be no need to deviate from profit-maximising investment. Hence, our analysis cannot explain why *Nord Stream* is built. In this section, we extend the model to analyse the role of commitment and strategic investment within a dynamic framework. For simplicity we consider only those players and pipeline options that turned out to be the most relevant in the previous section. That is, we consider Russia, Ukraine, Poland, and Belarus – countries that control three links: *Nord Stream*, *Yamal* (specifically: the existing *Yamal 1* and a possible *Yamal 2*), and *South* (specifically: the existing infrastructure and a possible upgrade).

Rational players will anticipate the impact of current actions on future bargaining and try to extend their cooperation beyond the current period.

As before, we assume that, in any given period, the players operate the existing transport system efficiently and share profits according to the Shapley value. In doing so, they take the existing capacities as given. In other words, in every period the players play a 'status quo' multilateral bargaining game. In the dynamic setup, however, they can also invest in new capacities, which will become available with some delay. Furthermore, they can grant each other long-term access rights. Both activities together will determine the 'status quo' of future games.[15] Rational players will anticipate the impact of current actions on future bargaining and, hence, try to extend their cooperation beyond the current period. Cooperation spanning over long periods of time requires credible commitments to make payments in the distant future, not to obstruct access to pipelines, and to stick to an investment schedule. In principle, there are two mechanisms to coordinate activities in such a dynamic framework. One rests on explicit contracts, which are enforced by independent institutions. The other is based on agreements, enforced by the mutual threat of the participants to terminate cooperation. We consider both mechanisms in turn.

Since the players are sovereign nations, long-term cooperation based on explicit agreements requires a strict rule of law, independent from political influence, within a country – or even better, international institutions to enforce such contracts. In the absence of such an institutional framework, countries lack the ability to make credible commitments. Since the focus in this section is on investment and not the sharing of profits, we assume that all players who could, in principle, enter explicit long-term agreements form a coalition that determines investment and network access rights to the best advantage of the whole group.[16] All other players remain on their own. In equilibrium, the coalition and all single players maximise their expected payoffs (net of initial

14 57% + 7/12* (89% - 57%) + 1/2* (100% - 89%) = 81%

15 In order to focus on the dynamics of strategic interaction, we assume that the economic environment is stationary, i.e., we abstract from demand growth, depletion of gas fields, technical progress, and so on.

16 Here, the notion 'coalition' has a different meaning than in Section 3.2, where it referred to all possible sub-coalitions in a bargaining situation. Now, we consider a group of players forming a 'pre-coalition' or 'strategic alliance' in advance of such a bargaining situation in order to change the bargaining game to its own advantage. It is straightforward to calculate how such a coalition would share its joint profit using the principles used for calculating the Shapley value (Owen 1977).

investment cost) from future bargaining – given the equilibrium strategies of the other actors (non-cooperative Nash-equilibrium). In Hubert and Ikonnikova (2004) and Hubert and Suleymanova (2006) it is shown that this may involve underinvestment in cheap pipelines as well as overinvestment in expensive ones. The possibility of underinvestment is a variant of the well-known hold-up problem. If the returns on investment are *ex ante* not contractible but shared according to some bargaining rule, the incentives to invest are lower than they would be otherwise. Overinvestment results from an attempt to create countervailing power.

With repeated interaction, cooperation can be supported by mutual threats to retaliate if others defect.

With repeated interaction, cooperation can be supported by mutual threats to retaliate if others defect. Following the literature on industrial organisation, we will refer to this form of cooperation as collusion. The aim of collusion is to raise the profits of the supply chain and avoid the inefficiencies associated with strategic investment. Since the enforcement of collusion does not depend on independent institutions, all players and the coalition can be involved. However, to sustain cooperation, threats have to be credible and the long-term gains from sticking to cooperation have to outweigh the short-term gains from deviation, which would be followed by retaliation from other players. Due to these constraints, collusion is more limited in scope than legally enforceable explicit agreements. We envisage a tacit agreement on a system of transfers and investments between the coalition of players able to commit and all other players. This tacit agreement is supported by the mutual threat to revert to non-cooperative behaviour if one party deviates from the agreement (so called trigger strategies). In practical terms, cooperation is terminated if one player starts bargaining for an increase of his assigned share or if one player deviates from the agreed investment schedule. The former is obvious. It is not possible to increase the share of one party without renegotiating all payments. The latter is because investment in transport capacity is easily observable. Upon observing that a player deviates from cooperative investment, all others anticipate that cooperation will fail once the capacities become available. Backward induction leads them to defect immediately.

While cooperation breaks down immediately, the full impact will be felt only with a delay. Initially, non-cooperative payments reflect players' bargaining power for given transport capacities. At this juncture, a deviating party would make a profit. Once capacities increase to their non-cooperative level, profits decrease. This corresponds to the punishment phase. To sustain collusion, the present value of future income from collusion must not be less than what can be obtained by defecting. Unfortunately, the equilibrium in dynamic strategies is not unique. In the following, we will focus on two borderline cases. At one extreme, players fail to collude, hence, only those players who can make long-term commitments cooperate. At the other, players collude to support the highest profits compatible with the dynamic incentive constraint.

All this leaves us with a fairly complex framework for the analysis. First, we have to decide which countries are able to commit and, hence, form a coalition. Second, we have to determine how the members of this coalition assign access rights so as to enhance their bargaining power as a group in future negotiations. Third, we have to analyse how the players invest, taking into account the impact of capacities on bargaining power for a given access regime. Finally, we have to distinguish between two possible equilibria: (i) a non-collusive one, in which players cooperate only within coalitions and act non-cooperatively *vis-à-vis* outsiders; (ii) a collusive outcome, characterised by the highest total profit that trigger strategies can support.

As to the ability to make credible long-term commitments, we consider four scenarios. As a benchmark (case 1), we assume that all countries can commit and, hence, form a grand coalition that invests so that total profits of the supply chain are maximised. In our standard scenario (case 2), we assume that only Poland can make long-term commitments. As an EU member, Poland can give private companies, even if they were fully owned by a foreign state, considerable legal protection through its and the European legal system. In this case, we thus have a coalition between Russia and Poland *{R,P}*.[17] For comparison, we look at two enlargements of this coalition. In one (case 3), Belarus can commit – in addition to Poland – and thus forms a coalition with Russia and Poland *{R,P,B}*. In the other (case 4), Ukraine can commit – in addition to Poland – and thus forms a coalition with Russia and Poland *{R,P,U}*. The last two cases appear unrealistic under current political circumstances. That said, case 3 might reflect the situation in the mid-1990s, when Belarus' independence from Russia was perceived to be very limited, so that opportunistic re-contracting was not considered a threat. And case 4 could be seen as reflecting a situation in which Ukraine, moving towards the European Union, subjects itself to international arbitration.[18]

4.2 Equilibrium investment in the Eurasian gas transport system

We calibrate the model using the same assumptions on pipeline cost as in Section 3. In addition, we assume a three-year construction period for pipelines, that is, pipelines come on stream three years after investment decisions have been taken. As for gas demand, we envisage substantial growth, such that a capacity increase of about 30 percent (or 30 bcm/a) will become necessary. These assumptions should be taken as an upper bound for reasonable expectations around 2005 (for further details on calibrating the model see Hubert and Suleymanova 2006).

Computed payoffs reveal that strategic considerations are of considerable importance for investment in the Eurasian gas transport network.

The equilibrium capacities under non-cooperative behaviour ('no collusion') and cooperative behaviour ('collusion') are displayed in Table 3. We start from the existing capacities *South* (70 bcm/a), *Yamal* (28 bcm/a), and *Nord Stream* (0 bcm/a) – to which we add the equilibrium investment. The figures reveal that strategic considerations are of considerable importance for investment in the Eurasian gas transport network. To start with the benchmark (case 1), in which all countries can commit and, thus, act like an integrated monopoly against customers in Western Europe. The profit-maximising capacity is 128 bcm/a, which is provided at minimal cost. The optimal network extension is to, first, upgrade *South* by 15 bcm/a and, then, expand *Yamal* by another 15 bcm/a. It follows that *Yamal 2* with its planned capacity of 28 bcm/a (see Section 2.2) would be built only some time after upgrading the *Southern System* and slowly taken to full capacity.

Now consider the most realistic scenario in which only Poland can commit (case 2). In the no-collusion variant, the players fail to upgrade *South* or invest in *Yamal*. Instead, *Nord Stream* is built with a staggering capacity of 80 bcm/a. With 178 bcm/a, the aggregate capacity is much larger than the profit-maximising one. Furthermore, almost one-fifth of the capacity would not be needed for transporting gas to Western Europe. Given our assumption of a fairly elastic long-run demand for Russian gas, the impact on quantities is stronger than the impact on prices.[19] The equilibrium price is 5 percent below the monopoly price, which is the price resulting from a grand coalition, while the quantity of Russian gas is up by 13 percent.

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17 In such a coalition Poland would commit to grant access at a rate less favourable than its short-term bargaining position suggests. As a result, Russia's ability to make long-term commitments is not at stake.

18 Hubert and Ikonnikova (2004) analyse in some detail how the different coalitions would optimally modify the access regime. Using results from Segal (2003), they prove that: (i) the coalition *{R,P,B}* would grant Russia access rights to the sections of *Yamal* in Poland and Belarus; (ii) the smaller coalition *{R,P}* would not change the natural access regime (as this would weaken the bargaining power of coalition members because Belarus is complementary to Poland in the presence of Russia); (iii) the coalition *{R,P,U}* would grant Russia access rights to *South*.

19 Specifically, the following linear function has been assumed: $p = 170 - 0.35q$, which is quite elastic at the current quantities.

Given this huge overinvestment, the supply chain could gain much from collusion. In the collusive equilibrium, transit countries voluntarily restrain their claims on profits, and Russia abstains from investing in *Nord Stream*. The credible threat to massively invest in *Nord Stream* is a strong enough deterrent for Ukraine and Belarus not to exploit their bargaining position to the full. The threat is so powerful, that it is even possible to increase the capacity of *South* in the Ukraine, first, by renovating the compressor stations (15 bcm/a). The profit-maximising network extension of case 1, however, is not feasible in the collusive equilibrium. Rather than switching to *Yamal* after exhausting the cheap upgrading option at *South*, the players continue to invest in *South* by installing new pipelines with a capacity of 12 bcm/a. As a result, the collusive equilibrium yields a network capacity that is even lower than in the profit-maximising equilibrium. Tight capacities and slightly higher prices make it the worst-case scenario for customers in the West.

Table 3. Equilibrium gas transport capacity [bcm/a] under alternative scenarios

	South	Yamal	Nord Stream	Total	Used
Case 1: all countries can commit *{grand coalition}*	70+15	28+15	0	128	128
Case 2: Poland can commit *{R,P}*					
No collusion	70	28	0+80	178	145
Collusion	70+15+12	28	0	125	125
Case 3: Poland and Belarus can commit *{R,P,B}*					
No collusion	70	28+85	0	183	145
Collusion	70+15	28+21	0	134	134
Case 4: Poland and Ukraine can commit *{R,P,U}*					
No collusion	70+15+23	28	0	136	136
Collusion	70+15+15	28	0	128	128

Notes: R ≡ Russia, B ≡ Belarus, P ≡ Poland; U ≡ Ukraine; Letters in { } show members of coalition.

That investment in Nord Stream is well under way strongly suggests that Russia and key gas transit countries failed to realise the potential of dynamic cooperation.

How do real-world investment patterns compare to the implications of our analysis? That investment in *Nord Stream* is well under way strongly suggests that Russia and key gas-transit countries failed to realise the potential of dynamic cooperation. For all our assumptions on countries' ability to commit, investment in *Nord Stream* could have been avoided through dynamic collusion. Not surprisingly, the countries also failed to prevent underinvestment in *South* and *Yamal*. However, the magnitude of real-world investment is below our prediction for the non-cooperative equilibrium. We obtain a non-collusive investment of 80 bcm/a in *Nord Stream*. Current plans for this project are 60 bcm/a – of which half will be established in the first step. The difference may indicate that the countries managed to maintain at least a low degree of collusion. Alternatively, the demand assumption underlying our model might be too high compared to actually expected demand.

Finally, we turn to the role of commitment. All non-collusive equilibria feature large overinvestment to create countervailing power. If both Belarus and Ukraine cannot commit, countervailing power is created by investing in *Nord Stream*. If only Ukraine cannot commit (case 3), *Yamal* provides the leverage, and if only Belarus (case 4) is prone to re-contracting, expanding *South* provides countervailing power. In contrast, all collusive equilibria feature capacities close to those following from the profit-maximising benchmark (case 1). Nevertheless, the ability to commit determines which pipeline is expanded.

In the early 1990s, Belarus' independence from Russia was limited. Apparently, the players underestimated the risk from re-contracting. Otherwise, investment in *Yamal 1* cannot be explained in our framework. Currently, the country looks increasingly isolated from the West, which may force it back into Russia's arms. It is difficult to say whether this would make opportunistic re-contracting *vis-à-vis* Russia less likely. In any case, the development of *Yamal 2* has a chance only if Belarus is perceived as a partner able to make long-term commitments. This holds true independently of the type of equilibria in the market.

Although not very likely in the near future, Ukraine may fully implement the European Energy Charter – even move towards closer integration with EU. By providing a framework for international contract enforcement, the charter may enable Ukraine to credibly enter into long-term agreements, which, in turn, is a precondition for investment in *South* in any of the no-collusion equilibria. However, preliminary calculations show that it may already be too late for both countries. Once *Nord Stream* is operating with a capacity of 30 bcm/a, it makes little sense to invest in *South* or *Yamal* unless demand grows well beyond our assumptions.

5. Conclusions

Russian gas, currently pumped through Ukraine and Belarus, makes a very important contribution towards the energy needs of Western Europe, creating concerns about energy dependency, market power, and security of supply.

In the first part of the paper, we develop an analytical framework to analyse power in the supply chain of Eurasian gas. Applying cooperative game theory for multilateral negotiations, we derive the bargaining power of the different players endogenously from the architecture of the transport system and its possible extensions. As a next step, we quantify the strategic importance of each single option to extend the grid, by calculating how it changes the distribution of the profit. The most important lesson from this exercise is that pipelines have to be evaluated in the context of the whole network. *Bypass* – a possible pipeline through Poland and Slovakia – is explicitly designed to shortcut Ukraine. What at first glance may look as a powerful threat to Ukraine's strong position in the current network turns out to have very limited strategic relevance. Slightly more important is the option to extend the capacities on *Yamal*, which is also commercially attractive. However, by far the strongest impact on the bargaining power is exerted by *Nord Stream*. Although this project cannot compete commercially with the other options to increase transport capacity, it strengthens Russia's position more than all other options together. In a nutshell: competition between Belarus and Ukraine is of little strategic importance compared to an option for direct Russian access to customers.

In the past, gas transport through the extended pipeline system has been interrupted occasionally when Russia and transit countries failed to reach agreement on their own gas prices and transit fees. These very rare, very short, but highly publicised events gave the impression that due to conflicts along the transit routes, Russian gas is unreliable and expensive. The dynamic model analysed in the second part of this paper suggests the opposite may be true. Because the members of the supply chain for Russian gas failed to develop a stable long-term cooperation, the pipeline system is expanded and diversified beyond what is in the interest of Russia, Ukraine, and Belarus as group. Investment is partially driven by strategic considerations to increase bargaining power *vis-à-vis* transit countries, rather than consumers. As a result, Western European energy consumers will benefit, both in terms of prices and energy security, from a diversified transport system with substantial spare capacities. At the same time, energy dependency will grow because the fraction of Russian gas in the energy mix becomes larger.

It appears that the pipeline system is being expanded beyond what is in the interest of Russia, Ukraine, and Belarus as a group, with investment partly aiming at increasing bargaining power vis-à-vis transit countries, rather than consumers in the West.

However, potential transit countries in the European Union such as Poland, the Czech Republic, and Slovakia clearly suffer from the lack of an international institutional framework that would allow their eastern neighbours to make credible long-term commitments. If Ukraine and Belarus had developed a strong and commercially sound gas relationship with Russia in time, investment would have gone into *South* and *Yamal* rather than into *Nord Stream*.

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