

# The Economics of the South Stream pipeline in the context of Russo-Ukrainian gas bargaining

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## 1. Introduction

In 2009, natural gas consumption in the European Union (EU) totalled 503 billion cubic metres per year (bcm/y) (IEA, 2010), of which indigenous production accounted for 34%.<sup>1</sup> By 2030, natural gas consumption in EU27 is projected to grow at an annual growth rate of +0.6% (EC, 2008) or +0.7% (IEA, 2010). Meanwhile, EU indigenous production is anticipated to decline substantially (EC, 2008), and thus consumption will have to be increasingly met with external sources.

In 2009, Russian gas exports amounted to roughly one quarter of EU natural gas consumption (BP, 2010). Around 70% of Russian gas to Europe is transported through Ukraine before entering European markets. Russia's "difficult" gas relations with Ukraine since the fall of the USSR have resulted in several major gas transit disruptions. Incidents include transit disruptions through Ukraine for 4 days in January 2006 and the more severe disruption through Ukraine of two weeks in January 2009, affecting millions of customers in South-Eastern Europe and the Western Balkans (Pirani et al., 2009; Kovacevic, 2009; Silve and Noël, 2010).

Since the 1990s, Gazprom has started the construction of export pipelines aimed at bypassing Ukraine. It began with the Yamal-Europe I pipeline through Belarus and Poland in the 1990s. Recently, Gazprom and its large West-European clients initiated construction of the second bypass pipeline - Nord Stream, under the Baltic Sea. Moreover, within few years, Gazprom plans to build another pipeline – South Stream, under the Black Sea. The combined export capacity of the two latest bypass projects would exceed current Russian gas exports through Ukraine. Assuming that the Nord Stream pipeline is already under construction, the objective of this paper is to examine the economic rationale of Gazprom's investment in the South Stream pipeline.

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<sup>1</sup> Author's own calculations based on (IEA, 2010; BP, 2010).

The major contributions of this analysis to the debate on Russia's bypass pipelines and its strategic natural gas policy towards Ukraine are as follows: (i) to our best knowledge, this paper presents the first detailed economic analysis of the South Stream pipeline; and (ii) Russo-Ukrainian gas negotiations in the context of South Stream have not been analysed before. The question that we seek to answer with this analysis is as follows:

- What is the economic value of the South Stream project to Gazprom under:
  1. different scenarios of gas demand in Europe,
  2. different scenarios of transit interruptions through Ukraine, and
  3. different scenarios of transit fees through Ukraine?

The rest of the paper is organized as follows. We review existing literature concerning the South Stream project in Section 2. In Section 3 we outline the research framework. Before presenting the results, we summarize the natural gas simulation model in Section 4 and outline major assumptions and scenarios of the analysis in Section 5. Then, in Section 6, we present the major findings. In Section 7 we conclude the analysis.

## **2. Literature Review**

This section briefly summarizes the existing literature and debate surrounding the South Stream project. It begins with a brief summary of the current policy literature concerning Gazprom's investment in the South Stream project; particularly, its competition with the EU-backed Southern Gas Corridor. Then, the security of supply reasoning used to justify costly investment in South Stream, which saturates both expert analysis and media commentary, is discussed. Finally, limited efforts in the energy economics literature to systematically analyse South Stream investment are outlined.

Since its inception, the South Stream project has become politically controversial. This is especially true in the context of the EU's Southern Gas Corridor.<sup>2</sup> The new gas transport corridor is intended to bring gas to Europe from the Caspian region and the Middle East, bypassing Russia. The majority of analyses in the public domain focus on South Stream as a pipeline project that intends to foreclose potential competition coming from the Southern Gas Corridor (among others, see e.g., (Finon, 2009; Lajtai et al., 2009; Hoedt and

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<sup>2</sup> The Southern Corridor is a mix of pipeline projects that are supported by the EU: Nabucco, ITGI and White Stream.

Beckman, 2010; Paszyc, 2010)).<sup>3</sup> Thus, the ongoing debate concerning competition between the South Stream project and the Nabucco pipeline (the core project of the EU's Southern Gas Corridor) has led to the emergence of two camps – the supporters of South Stream and its opponents (Kazmin, 2009). In general, the supporters of South Stream argue that the project will 'feed' energy-hungry European markets and, more importantly, will improve the security of Russian gas supplies to Europe. On the other hand, the opponents question the economic feasibility of the South Stream project and its cost efficiency compared to the Nabucco pipeline. Further, they argue that the project will increase Europe's dependence on Russian gas, which contradicts its official policy goal of limiting its dependence on any one external supplier.

In the context of Russo-Ukrainian gas relations, South Stream is mainly viewed as a Ukrainian transit avoidance pipeline that would improve security of Russian gas supplies to Europe (see e.g., (Stern, 2009) and (Pirani et al., 2009)). Some experts argue that costly investment in South Stream could be justified if the transit risk premium through Ukraine is taken into account (see, e.g. Finon, 2009: p.12). Also, a few analyses briefly mention South Stream's strategic role in advancing Russia's political goals in Ukraine (see, e.g., (Michaletos, 2008; Nicola, 2010)). The reasoning is that, if South Stream is built, then most gas flows through Ukraine would be diverted to South Stream, putting substantial economic and, therefore, political pressure on Ukraine.

In general, the mainstream view on the South Stream project is based on the implicit assumption that the South Stream project is very costly and that using the Ukrainian transit system remains the cheapest option for Gazprom to export gas to Europe. Thus, so goes the view, South Stream investment may have: (i) political value to the Russian government, e.g., in advancing its influence over its 'near abroad' area and/or as a means of consolidating domestic support for Russia's current leadership<sup>4</sup>, (ii) strategic economic value to Gazprom (foreclosing competition from the Europe's southern corridor), and (iii) security of supply value to Gazprom and European consumers (South Stream as Gazprom's insurance against possible transit interruptions through Ukraine).

Despite the mainstream view in the policy literature on the South Stream project, there are very limited systematic analyses of South Stream investment in the energy economics literature that would examine some of the above-mentioned policy conclusions.

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<sup>3</sup> The web portal (Euractiv.com, 2011) contains concise and structured information about Europe's Southern Gas Corridor and its competing projects, including major political and expert views on this matter.

<sup>4</sup> See (Baev and Øverland, 2010) for a detailed discussion concerning the view of South Stream as a mega-project in consolidating domestic public support for Russia's 'tsarist' leadership.

Dieckhöner (2010) has used the TIGER natural gas infrastructure model to evaluate the importance of the Nabucco and South Stream projects to the security of gas supplies to Europe in terms of the risks of transit interruptions through Ukraine.<sup>5</sup> The author has found that, while both the Nabucco and South Stream projects increase security of supply to South-Eastern Europe, the latter project seems to be a better ‘security’ option than the former project when transit through Ukraine is disrupted (Dieckhöner, 2010). Nevertheless, Dieckhöner (2010) has not attempted to analyze whether it is economically justifiable for Gazprom to invest in South Stream in light of transit interruptions through Ukraine.

Whereas Dieckhöner (2010) has focused on security of supply issues, Smeenk (2010) has attempted to quantify the economic value of South Stream investment, focusing on the project as Gazprom’s pre-emptive strategy. Smeenk (2010) has used a real-option game approach in his analysis. Specifically, South Stream investment was analyzed using a two-stage game involving only Gazprom, assumed to be a dominant player, and a potential competitor/entrant. Smeenk (2010) has found that the net present value, NPV, of South Stream investment is positive due to economies of scale and strategic pre-emption. Smeenk has made a number of simplifications at both theoretical and empirical levels, which, if addressed in greater detail, may change the author’s results and conclusions.

Firstly, although Gazprom supplies a quarter of the EU’s annual gas consumption, this does not necessarily mean Gazprom will enjoy a first-mover advantage in South Stream investment, which requires substantial investment resources and political support from the EU.<sup>6</sup> Secondly, the assumed market structure (duopoly) is rather simplistic. Thirdly, the assumption that an entrant cannot make a strategic investment is rather ad-hoc, and sensitivity analysis on who moves first and what each player can do (i.e., invest strategically or commercially) is desirable.

At the empirical level, Smeenk (2010) has used an industry average CAPEX per unit of pipeline diameter and length in deriving capital costs for South Stream and a competing project. The CAPEX for pipelines varies greatly from one project to another due to project-specific factors such as route, financial strategy (such as debt/equity financing ratio) and business model (‘merchant’ pipeline or a pipeline project that is part of a vertically integrated company). Moreover, Smeenk has focused the analysis entirely on potential net growth in gas import demand, thus, avoiding the issue of Gazprom’s existing markets and

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<sup>5</sup> See (Lochner and Dieckhöner, 2010) for a description of the model and its applications.

<sup>6</sup> Gazprom intends to obtain political support for its South Stream project from the European Union in general and EU member countries in particular in order to achieve the same status as other pipelines that form part of EU-backed Southern Gas Corridor (Gazprom, 2010b).

utilization of existing routes (Ukraine, Belarus and Blue Stream). Furthermore, an assumption is made according to which gas flows through Ukrainian pipelines will gradually fall in line with a decrease in Gazprom's supply commitments under its existing long-term contracts; i.e., it is assumed that the servicing of new contracts will be shifted to South Stream. Thus, it was implicitly assumed that, either because of security of supply reasoning or due to cost efficiency, Gazprom will definitely use South Stream instead of the Ukrainian route. However, Smeenk (2010) has provided no analytical basis to support this assumption.

Despite the shortcomings in Smeenk's quantitative analysis, the author has provided a comprehensive qualitative framework (partly based on the framework advanced by (Victor et al., 2006)) to analyze Gazprom's infrastructure investments, and the aim of his stylistic quantitative model is to supplement his qualitative results.

To summarize, policy literature is rather ambiguous regarding the South Stream project, and limited efforts have been invested in quantifying and testing some of the policy conclusions. Therefore, the aim of this analysis is to focus on South Stream investment in the context of Russo-Ukrainian gas relations and risks of transit interruptions through Ukraine. In order to be rigorous and systematic, the analysis presented here focuses only on the cost efficiency of South Stream compared to the utilization of existing pipelines through Ukraine, taking risks of transit interruptions into account. This analysis does not attempt to reveal any strategic pre-emption value of South Stream investment and cost efficiency in pursuing this strategy.<sup>7</sup> The Southern Gas Corridor and competition for the energy resources (and thus competition between pipeline projects) of Central Asia and the Middle East is a complex issue with many stakeholders/players involved, and this analysis is by no means able to cover the whole complexity but only contribute to an understanding of the role and the relevance of Ukraine, as a major transit country of Russian gas, in motivating Gazprom to invest in the South Stream pipeline system.

### **3. Methodology**

The analysis presented in this paper is based on two interconnected steps. Firstly, the cost of building and using the South Stream system is derived. Secondly, using a strategic, game-theoretic Eurasian gas trade model (for details see (Chyong and Hobbs, 2011)), the economic value of South Stream system to Gazprom is derived under different scenarios of market developments. The following sections focus on the derivation

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<sup>7</sup> The question of whether pre-empting a competing project (e.g., Nabucco) through the Ukrainian route would be more efficient than through the South Stream system deserves a separate analysis, which is addressed in a forthcoming paper.

of the value of South Stream. For details of the derivation of the costs of South Stream, uncertainty analysis of these costs and related assumptions, see Appendices in (Chyong and Hobbs, 2011).

### 3.1. Economic Value of South Stream investment

The logic of cost-benefit analysis is followed in the derivation of the economic value of the South Stream system under different scenarios and assumptions. The value of South Stream investment is derived by comparing Gazprom's anticipated total profit between 2011 and 2040 when the South Stream project is built with Gazprom's profit when it is not built.<sup>8</sup> This is shown in the following equation:

$$PV^{SS} = \sum_{t=2011}^{2040} \frac{(Profit_t^{+SS} - Profit_t^{-SS})}{(1 + Discount Rate)^{(t-2011)}} \quad (1)$$

where  $PV^{SS}$  is the present value of Gazprom's investment in the South Stream system,  $Profit_t^{+SS}$  is Gazprom's annual profit when the South Stream system has been built, and  $Profit_t^{-SS}$  is Gazprom's annual profit if the pipeline has not been built; the discount rate applied to this calculation is the South Stream project discount rate discussed in Appendix F in (Chyong and Hobbs, 2011). Gazprom's profit under different scenarios and assumptions is derived from the gas market model described in (Chyong and Hobbs, 2011).

### 3.2. Economic Value of South Stream in terms of Risks of Transit Disruptions

The expected present value of the South Stream system in terms of risks of transit interruptions through Ukraine is computed as follows:

$$E[PV_d^{SS}] = PV^{SS} + P_{td} \left[ \sum_{t=2011}^{2040} \frac{(Profit_{td}^{+SS} - Profit_{td}^{-SS})}{(1 + Discount Rate)^{(t-2011)}} - PV^{SS} \right] \quad (2)$$

where  $E[PV_d^{SS}]$  is the expected NPV of South Stream investment under transit disruption scenario  $d$ ,  $Profit_{td}^{+SS}$  is Gazprom's profit under transit disruption scenario  $d$  when South Stream is built,  $Profit_{td}^{-SS}$  is Gazprom's profit under transit disruption scenario  $d$  if the South Stream system is not built, and  $P_{td}$  is the probability of transit disruption  $d$  through Ukraine in year  $t$ , which is assumed to be a random variable with uniform distribution in  $[0;1]$ .

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<sup>8</sup> South Stream's economic lifetime is assumed to be 25 years. Since it is assumed that South Stream will be built by 2016, the time frame of the analysis goes up to 2040 to cover the lifetime of the project.

Gas transit interruptions through Ukrainian pipelines are implemented as follows: (i) we run our gas simulation model under different demand scenarios, (ii) we record Russian gas transit quantities through each pipeline of the Ukrainian transit system, and (iii) we then set (exogenously) limits on these transit quantities according to the assumed transit disruption scenario  $d$  (see Section 5: Table 3).

One should note that the timing of disruptions through Ukraine, i.e. when exactly interruptions might occur in the time frame of our analysis (2011-2040), makes a difference to the expected NPV of South Stream investment, since a disruption in 2012, for example, has a different value to Gazprom than the value of an interruption occurring in 20 years, due to discounting (and the larger the discount rate the larger should be such differences). Thus, an ‘impatient’ Gazprom would prefer to have South Stream at its disposal as soon as possible if it expects transit disruptions through Ukraine in the near future. Therefore, deriving the expected NPV of South Stream under assumed disruption scenarios (Table 3) is not straightforward, since it is impossible to predict when disruptions through Ukraine might occur between 2011 and 2040 because such predictions depend on a range of known and unknown factors. Thus, for this analysis, it is assumed that a disruption through Ukraine might occur in any year between 2011 and 2040 with equal probability.

Further, it is assumed that Gazprom would not lose any cubic metres of natural gas (i.e. gas molecules are still in Gazprom’s fields) when transit through Ukraine is completely shut. In this sense, there might be little or even no economic loss to Gazprom when transit through Ukraine is disrupted because the gas not sold now can be sold later (admittedly at lower present value). Thus, the derived economic value of South Stream under the risks of transit interruptions only reflects Gazprom’s savings in financial losses that might arise from transit interruptions through the Ukrainian route when South Stream is built compared to the scenario when the pipeline is not built.

#### **4. Model Summary**

A strategic gas simulation model, presented in (Chyong and Hobbs, 2011), has been used to quantify the economic value of South Stream under different demand scenarios, transit fees through Ukraine and transit disruption scenarios. Computational gas market models, based on a non-cooperative game-theoretic framework, have been used extensively in recent research on structural issues of European and global gas market developments (see e.g., (Boots et al., 2004; Zwart and Mulder, 2006; Holz et al., 2008; Egging et al.,

2009; Lise and Hobbs, 2009; Zwart, 2009)).<sup>9</sup> Security of gas supply to Europe (both long-term resource and infrastructure availability and short-term gas disruption events) has also been analysed using gas market models (see e.g., (Holz, 2007; Egging et al., 2008; Lise et al., 2008)).

The strategic gas market model applied to this analysis contains all gas producers and consumption markets in Europe (see Table 1). The model includes the following players: producers, transit countries, suppliers, consumers, transmission system operators, TSO, and LNG liquefaction and regasification operators. The objective of each player in the model is to maximize the profits from their core activities.

**Table 1:** Gas producing and consuming countries in the model

Consuming countries		Producing countries	
Finland	Slovak Republic	Algeria	Romania
Baltic States <sup>10</sup>	Czech Republic	Azerbaijan	Russia
Austria	Hungary	Denmark	Trinidad and Tobago
Belgium	Romania	Egypt	Turkmenistan
Spain and Portugal	Poland	Germany	UK
France	Turkey	Hungary	Ukraine
Netherlands		Italy	Uzbekistan
Italy		Kazakhstan	
UK		Libya	
Germany		Netherlands	
Slovenia		Nigeria	
Bulgaria		Norway	
Balkan States <sup>11</sup>		Oman	
Croatia		Poland	
Greece		Qatar	

Producers and consumers are connected by pipelines and by bilateral LNG shipping networks. Therefore, producers must pay transmission fees and LNG costs to transport gas to consuming countries. It is assumed that producers can exercise market power by playing a Cournot game against other producers. However, TSOs are assumed to be competitive and to grant access to the pipeline and LNG import infrastructure to those users who value transmission services the most.<sup>12</sup> This would result in transmission and LNG regasification fees based on long-run marginal costs and a congestion premium if infrastructure capacity constraints are binding. Although producers can exercise market power by manipulating sales to suppliers, it is assumed that producers are price-takers with respect to the cost of transmission and LNG

<sup>9</sup> For an exhaustive review of gas simulation models applied to the analysis of European gas markets see, e.g., (Smeers, 2008).

<sup>10</sup> Baltic States: Estonia, Lithuania, Latvia; Iberian Peninsula: Spain and Portugal

<sup>11</sup> Balkan States: Serbia, Bosnia and Herzegovina, Macedonia and Albania

<sup>12</sup> As Smeers (2008) argues, the assumption of the efficient pricing of transmission costs is somewhat optimistic and diverges from the reality of natural gas transmission activities in European markets. However, recent agreements between private companies and European antitrust authorities (such as the capacity release programme agreed between GDF SUEZ, ENI, E.ON and the EC) promise much more competitive access to both transmission pipelines and LNG import terminals (EC, 2009a; EC, 2009b; EC, 2010).

services. These assumptions are consistent with other strategic gas models (Boots et al., 2004; Egging et al., 2008; Lise and Hobbs, 2008).

In each consuming country there are a certain number of gas suppliers who buy gas from producers and re-sell it to final customers, paying distribution costs. Following Boots et al. (2004), the operation of suppliers is modelled implicitly via the effective demand curves facing producers in each country.<sup>13</sup>

Final prices for natural gas may differ among countries (markets). Partly, this is due to the geographical locations of consumers and producers - countries that are closer to gas sources enjoy lower prices than countries that are further from gas sources because of the considerable transportation costs, including possible congestion fees on transmission pipelines and transit countries' mark-ups due to the exercise of market power. Apart from differences in transport costs, gas prices can also differ significantly due to different degrees of competition among producers and suppliers in a particular national market.

**5. Scenarios and Assumptions**

Future gas demand in Europe, as well as gas prices, may greatly influence the economics of the South Stream project. The analysis of South Stream is carried under three scenarios of European gas demand (see Table 2). The base case scenario is based on the IEA's 2009 forecast (IEA, 2009), while for our high demand case we average the projected growth rates from the IEA's *World Energy Outlook*, WEO, published between 2000 and 2007. For our low demand case, we assume that European gas consumption will decline at a rate of 0.1% per annum, similarly to the WEO 2009's "450 Scenario". The gas prices used in the model are based on the IEA's (2009) price outlooks. Since it is assumed that the economic life time of the South Stream system is 25 years, and that the pipeline will come into operation in 2016, the period of the analysis is 2011-2040; thus it is assumed that gas demand, prices and all other parameters are constant after 2030.

**Table 2:** Assumed growth rate of gas consumption and prices: 2010-2030

	<b>High Demand Case</b>	<b>Base Case</b>	<b>Low Demand Case</b>
Average Compound Annual Growth Rate of Gas Demand			
Western and Southern Europe	+2.07%	+0.7%	-0.1%
Central and Eastern Europe	+2.07%	+0.8%	-0.1%
Balkan Countries	+2.07%	+0.8%	-0.1%
Average Compound Annual Growth Rate of Gas Prices			
All consuming countries in the model	+1.4%	+1.4%	+0.3%

<sup>13</sup> In the derivation of the effective demand curve, suppliers operating in each country are assumed to be identical. As Smeers (2008) argues, this assumption does not correspond to the reality of European downstream markets.

In order to derive the NPV of South Stream in terms of the risks of transit interruptions through Ukraine, the following disruption scenarios are assumed:

**Table 3: Transit Disruption Scenarios through Ukraine**

<b>Disruption Scenarios</b>	<b>Duration of Disruptions</b>	<b>Frequency of Disruptions</b>	<b>Total days of disruptions</b>
Moderate Disruption Case	3 weeks	5 disruptions in 2011-2040	105 days
Severe Disruption Case	6 weeks	10 disruptions in 2011-2040	420 days

The disruption scenarios are for analytical purposes only and do not constitute forecasts of transit disruptions through Ukraine. To simplify the analysis, it is assumed that the probabilities of disruptions in any period are independent (e.g. gas transit disruption in 2009 through Ukraine has no effect on the probability of future disruptions through Ukraine.). Also, it is not distinguished when exactly the disruption would occur during a particular year (winter or summer), which would require explicit modelling of storage in the gas simulation model. Therefore, the results should be treated as annual average values.

To derive the NPV of South Stream investment under different assumptions about transit fees through Ukraine, three scenarios of transit fees through Ukraine are considered (Table 4). The transit fees assumed in Table 4 exclude fuel costs for compressors. This cost, which amounts to 3% of total transit volume (Ukrainska Pravda, 2009), is accounted for in the simulation model as additional gas provided by Gazprom in kind (see model formulation in (Chyong and Hobbs, 2011)).

**Table 4: Scenarios of Transit Fees through Ukraine (US\$/tcm/100km)**

	<b>Short-Run Transit Cost</b>	<b>Transit fee under current contract</b>	<b>High transit Fee</b>
Transit fee	0.50	2.07	5.11

It was reported that for gas transportation services through the Belarus' section of the Yamal-Europe pipeline, Gazprom pays US\$ 0.50/tcm/100km to Beltransgaz (the operator of the Yamal-Europe pipeline) which includes only the operating and O&M costs of the pipeline. For this analysis, this value (US\$0.5 per tcm/100km) is assumed for SRMC through the Ukrainian transit system.

According to the current long-term transit contract, the transit fee through Ukraine is determined based on a formula which specifies the dynamics of the transit fee as a function of the inflation rate in Europe and the gas import price for Ukraine (Ukrainska Pravda, 2009). The average value of the transit fee based on this formula is US\$ 2.07/tcm/100 km (for details of the calculation of this value see Appendix C: Section 7.3.1 in (Chyong and Hobbs, 2011)).

For the high transit fee scenario we assume US\$ 5.11/tcm/100km. This particular transit fee was taken from (Kovalko and Vitrenko, 2009a). These authors argue that US\$ 5.11/tcm/100km is an economically justifiable transit fee that Gazprom should pay. The analysis presented by Kovalko and Vitrenko (2009a) contains a quite detailed financial and economic analysis of Naftogaz's transit activities.<sup>14</sup>

For this analysis, we assume that only producers can exercise market power and that downstream suppliers are competitive. This assumption is motivated by the results of our model validation, discussed in (Chyong and Hobbs, 2011), which show that model results under an upstream oligopoly fit better with the real data than the double marginalization or perfect competition market scenarios.<sup>15</sup> Although formally only producers may exercise market power, the implicit assumption that we adopt is that producers and suppliers act simultaneously to extract the whole monopoly profit from the market and then share that profit relative to their bargaining power. Compared to the successive oligopoly approach, in which upstream producers and downstream suppliers are assumed to exercise their market power in sequence, such vertical coordination to exercise market power can result in greater sales and lower prices, and therefore a smaller loss of welfare (Smeers, 2008). This assumption is consistent with the traditional view of the structure of European gas markets (Smeers, 2008).

Based on this assumption, the resultant profit of producers should be treated as the profit of an integrated company producing and selling gas directly to final customers (i.e., the whole monopoly rent from a wellhead to a burner tip). Thus, Gazprom's profit, which it receives by selling gas at final prices, should be re-adjusted after simulation runs, since in reality Gazprom sells gas to suppliers at border prices.

In 2002-2009, the average border price accounted for about 53% of the average final prices in Germany (see Table 5).<sup>16</sup> This average value is relatively consistent with simulation results found by Chyong and Hobbs (2011) under the double marginalization scenario (in which producers and suppliers exercise market power in sequence).<sup>17</sup> Thus, for the calculation of Gazprom's profit its border prices are assumed to be 53% of simulated gas prices for final consumption. The derivation of the economic value of the South

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<sup>14</sup> Both Kovalko and Vitrenko were senior officials at Naftogaz responsible for transit and supply pricing policy (until 2007, Kovalko was Deputy CEO of Naftogaz and Vitrenko was Chief Advisor to the CEO of Natogaz). Officials from Naftogaz of Ukraine suggested this article (Kovalko and Vitrenko, 2009a) as an example of what could be an "economically" justified transit price (Naftogaz of Ukraine, 2009).

<sup>15</sup> See Section 4 (p.35-36) and Appendix G in (Chyong and Hobbs, 2011)

<sup>16</sup> German border and final prices were chosen for several reasons: (i) there is very limited (publicly available) information about border prices in Europe markets, and (ii) Germany is one of the largest gas markets in Europe and is also the largest market for Russian gas. Thus, both German border and final prices can be reasonably used to evaluate the economic value of South Stream investment.

<sup>17</sup> Particularly, the simulated average border price in Europe under the double marginalization case was about 62% of the average price for final consumption in Europe (see Chyong and Hobbs (2011): Table 4 on p.43).

Stream system to Gazprom is based on this assumed share (i.e. 53% of final prices obtained from model simulations).

**Table 5: Real Border and Final prices (US\$/tcm)**

	<b>Average gas price at German Border<sup>a</sup></b> [1]	<b>Average final price in Germany<sup>b</sup></b> [2]	<b>Border price as % of final price</b> [3]
2002	121	246	49%
2003	153	285	54%
2004	163	329	50%
2005	223	426	52%
2006	305	545	56%
2007	310	644	48%
2008	446	734	61%
2009	349	649	54%
<b>Average</b>			<b>53%</b>

Source: <sup>a</sup>(Gas Strategies, 2010); <sup>b</sup>(Eurostat, 2010)

Note: [3]=[1]/[2]x100%

As was mentioned, since the Nord Stream pipeline is already under construction, in this analysis it is assumed that the pipeline will be operational by 2013 with a total transport capacity of 55 bcm per year. Further, Belarus' transit pricing and the possibility of exerting market power vis-a-vis Gazprom can also be simulated with the model. However, for this analysis we assume that Belarus' transit fees are fixed at 2010 levels. This would not affect our results since the Yamal-Europe route and the South Stream route are destined to reach distinctly different markets. All other market assumptions, such as gas infrastructure capacities and costs (production, transport etc.), used for this analysis are extensively documented in Appendix C in (Chyong and Hobbs, 2011).

## 6. Results

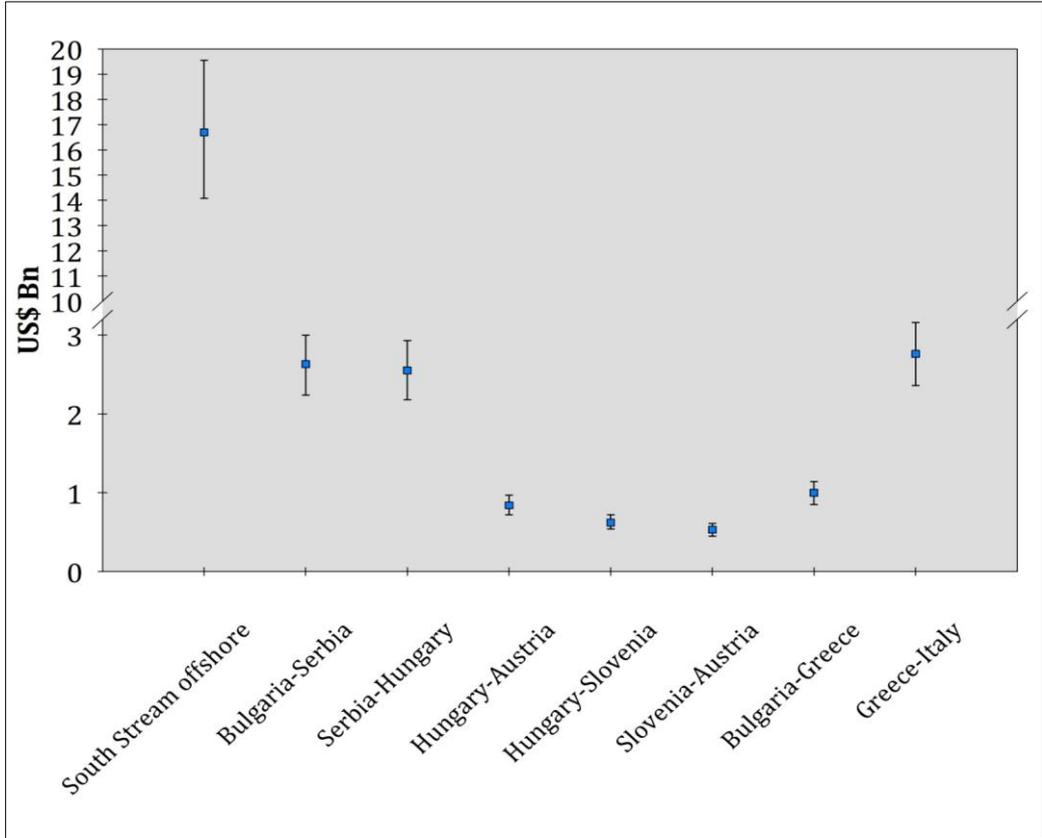
In this section, the main results of this analysis are presented. First, the costs of building and using the South Stream pipeline are presented in the next section. Then, in Section 6.2, the economic value of South Stream investment under different demand scenarios in Europe is discussed. In Section 6.3 the analysis of the transit risk premium is presented, and Sections 6.4 and 6.5 outline the bargaining value of South Stream.

### 6.1. The Costs of Building and Using South Stream

The first step in the analysis of the economics of the South Stream route is to compare the unit cost of transporting through this new system with that of the Ukrainian route. This comparison requires a derivation of the total investment cost of the South Stream system. Then, on the basis of these cost estimates, levelised transportation costs, LTC, between different production fields (in Russia and in Central Asia) and a

particular final gas market are calculated. The LTC through South Stream is derived by dividing the present value of the total investment cost and operational cost of the South Stream system by the present value of the total volumes of gas transported over 25 years through this system. South Stream’s investment and O&M costs was derived using the methodology and data presented in Appendices D and F in (Chyong and Hobbs, 2011).

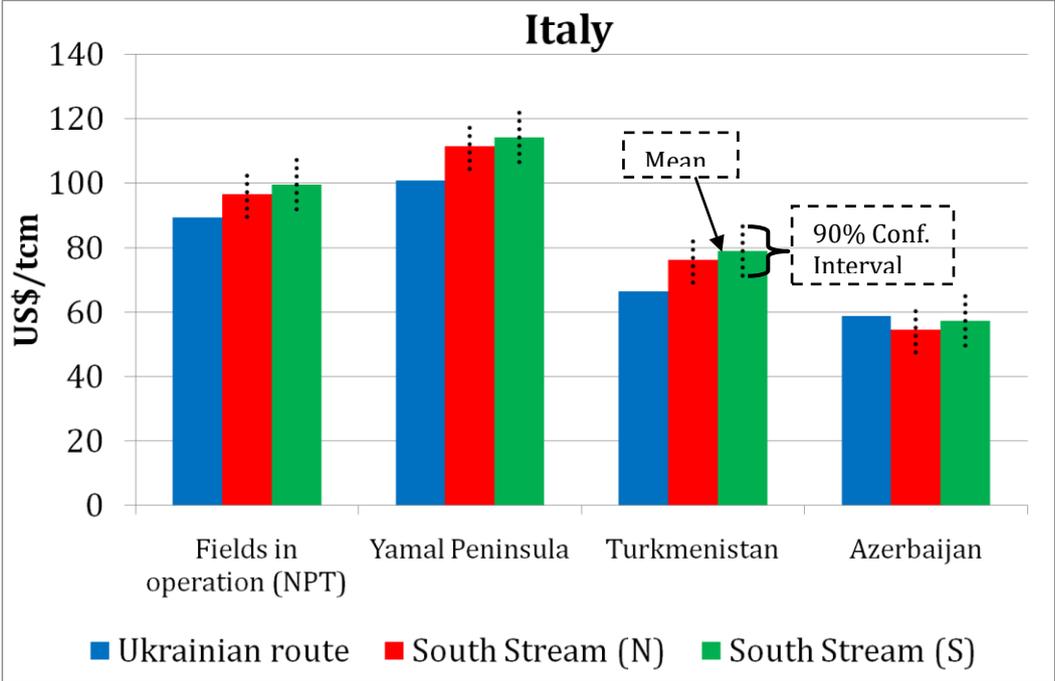
Figure 1 shows the minimum, the average and the maximum values for each component of the South Stream system. These figures include the construction cost, the cost of compressors and the cost of debt financing. The total investment cost of the South Stream system varies between US\$ 23 bn and US\$ 32 bn. The single largest component of the South Stream system is the offshore pipeline underneath the Black Sea, which accounts for about 60% of the total capital cost of the system.



**Figure 1:** South Stream’s Total Investment Cost

Figures 2 and 3 show the average levelised transportation costs (with 90% confidence intervals) from major gas production sites in Russia and Central Asia to Italy and the Balkan countries. The levelised cost through the South Stream system was derived assuming that the system would be fully utilised during its economic life-time. The levelised costs show how much each pipeline should charge in order to pay back its investment costs and total O&M costs over the life-time of the pipeline (for details of the calculation of levelised transport costs see Appendix E in (Chyong and Hobbs, 2011)).

As envisaged by Gazprom (see Figure A.1 in Appendix A), the South Stream route allows the company to export gas to Italy through the northern route (South Stream North [N]), passing through Serbia, Hungary and Slovenia, and the southern route (South Stream South [S]), through Greece and under the Ionian Sea to South Italy. Thus, according to the cost estimates of the South Stream pipeline, it is cheaper to export gas to Italy via Ukraine if the gas originates from Russia or Turkmenistan (Figure 2). The southern route of the South Stream pipeline is a bit more expensive than its northern route due to a higher taxation rate in Greece and also due to the higher construction costs of the offshore pipeline that goes under the Ionian Sea. However, transporting gas from the Azeri-Russian border through South Stream appears to be cheaper than using the Ukrainian pipelines.



**Figure 2:** Transportation Costs to Italy<sup>18</sup>

South Stream can be used to supply gas along its route, e.g. to Bulgaria, Turkey, Greece and Serbia.<sup>19</sup>

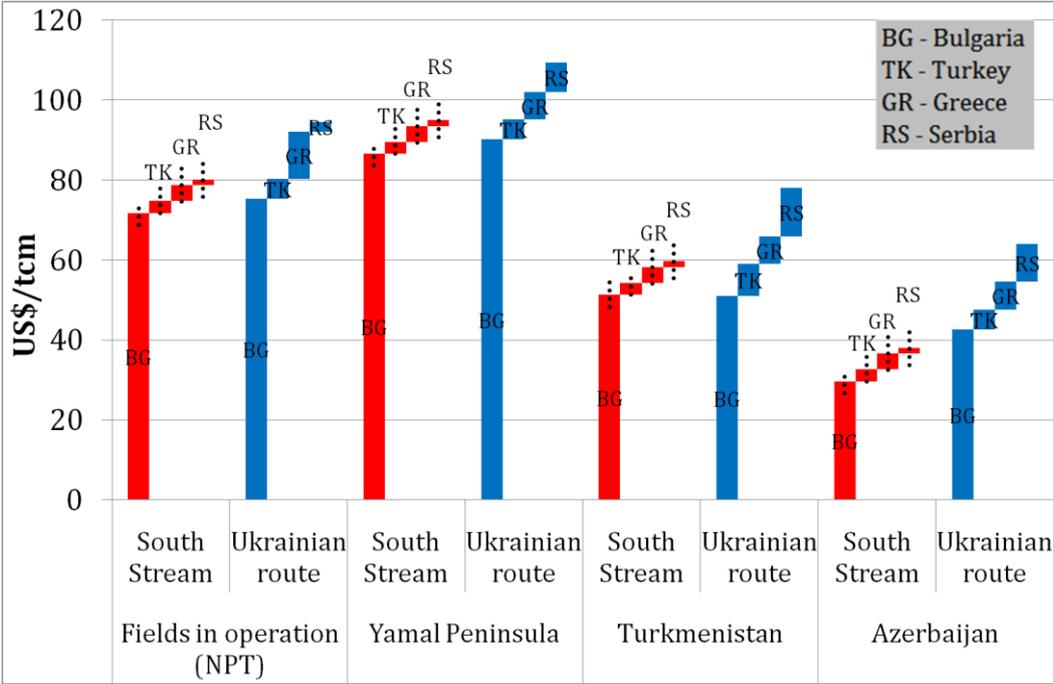
Figure 3 reports the average transport costs through the Ukrainian pipelines and South Stream to these markets. It is clear that, for these four markets, Gazprom should use the South Stream pipeline as it appears to be cost competitive compared to the Ukrainian route. However, one should note that these four markets are smaller than Gazprom’s two largest markets in the EU – Germany and Italy. In 2009, Gazprom’s total supplies to these four Balkan markets were 26 bcm, while its total supplies to Germany and Italy were 53 bcm (Gazprom, 2010a). Moreover, the construction of Gazprom’s Blue Stream pipeline to Turkey was partly

<sup>18</sup> South Stream (S) is the southern route of the proposed pipeline system, which will pass through Greece then under the Ionian Sea to South Italy near Otranto; South Stream (N) is the northern route, which will pass through Serbia, Hungary and Slovenia to the Austrian-Italian border, near Arnoldstein (for details see Appendix A: Figure A.1).

<sup>19</sup> Also, gas can be supplied to Hungary, Slovenia, and Austria along the South Stream route.

based on debt financing, and Gazprom must ensure that the pipeline is sufficiently utilized; therefore, one should expect that Gazprom might divert gas going through the Ukrainian route to Balkan countries but not gas through the Blue Stream pipeline.

It should be noted that the total transit cost through the Ukrainian route (Figures 2 and 3: “blue” bars) is based on its current transit fee (for details on calculation see Appendix C: Section 7.3.1 in (Chyong and Hobbs, 2011)). If Ukraine prices transit services based on long-run marginal cost, LRMC, or even based on short-run marginal cost<sup>20</sup>, then this would further disadvantage the South Stream route since LRMC (and SRMC) through Ukrainian transit pipelines is lower than its current transit fee.



**Figure 3:** Transportation Costs to Southern Europe

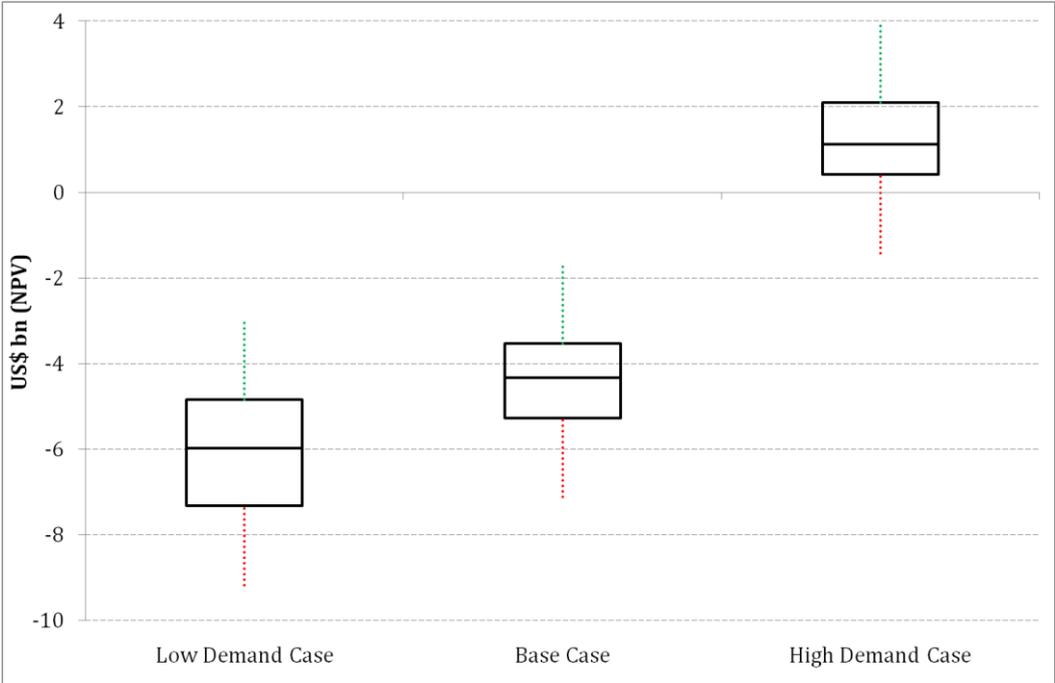
In general, the estimated costs of building and using the South Stream pipeline show that the pipeline in its current configuration (i.e. proposed routes and capacities) is not a cost efficient project compared to the Ukrainian route. Therefore, meeting future gas demand and/or pre-empting competing supplies from the Caspian and Middle East regions may be more cost-efficient through Ukrainian pipelines. However, it should be noted that at this point it is still unclear whether the value of the South Stream system to Gazprom will be negative or positive, since this would largely depend on gas demand and prices in Europe, as well as on future transit fees through Ukraine and risks of Ukrainian transit interruptions. In the subsequent sections, the net present value, NPV, of South Stream investment for Gazprom is discussed.

**6.2. The Economic Value of the South Stream System**

<sup>20</sup> It should be noted that transit pricing under short-run marginal cost would not reflect huge up-front capital cost of Ukraine’s transit system and thus is neither economically nor politically feasible for Ukraine to do so.

Using the strategic gas market simulation model described in (Chyong and Hobbs, 2011), and following eq. (1), the NPV of South Stream investment is derived. Figure 4 shows the NPV of South Stream investment to Gazprom under the three demand scenarios (see Table 2). The black boxes with solid lines represent the minimum, average and maximum economic values of Gazprom’s investment in the South Stream system, assuming average investment, operational and maintenance costs for the project (thus, the variability is due to the variance in discount rates only). The dotted lines show the impact on the project’s maximum and minimum NPV of capital and operational expenditures reaching their maximum and minimum values.

In low and base case demand scenarios, the South Stream system brings negative value to Gazprom and only in the high demand case is the value of South Stream investment positive. The average NPV of the South Stream investment is US\$ -6 bn in the low demand case, US\$ -4.3 bn in the base case and US\$ 1.1 bn in the high demand case.



**Figure 4:** NPV of the South Stream System under Different Gas Demand Scenarios

In the best case, when gas demand in Europe is relatively high (at an annual growth rate of +2.07%), and the (total) investment and operational costs of the South Stream system are low, the economic value of the pipeline could be as high as US\$ 4 bn over the lifetime of the system. However, in the worst case (i.e. a combination of the highest total investment and operational costs and the lowest gas demand scenario) the NPV of South Stream investment would be US\$ -9.2 bn over the lifetime of the pipeline.

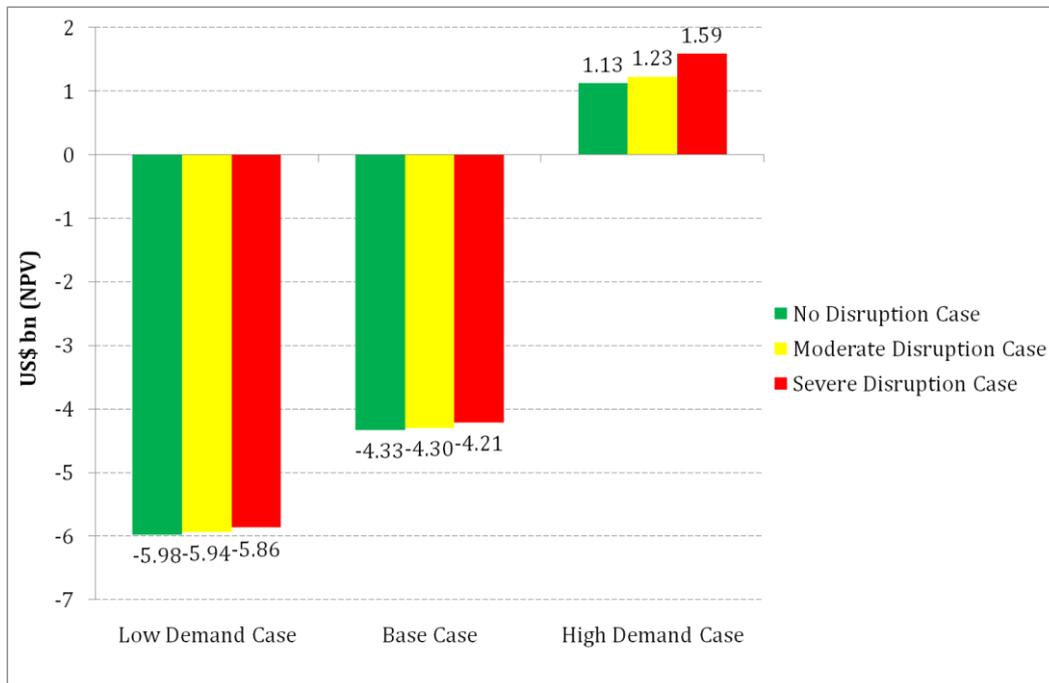
In general, these results confirm the comparative analysis of transport costs through the South Stream and Ukrainian routes presented in Section 6.1. Thus, only high demand in Europe justifies construction of South Stream and the project should be viewed as a demand-driven project. If gas demand in Europe expands moderately, then using Ukrainian pipelines is more cost efficient for Gazprom than building South Stream. However, some experts conclude that the risks of transiting gas through Ukraine justify the costly construction of the South Stream system. The next section examines this issue.

### **6.3. The Economic Value of South Stream in terms of Risks of Transit Disruptions**

Supporters of South Stream argue that the project will improve the security of gas supplies to Europe and that, if transit risk is taken into account, this might justify the construction of this costly pipeline. Gazprom originally planned that South Stream would have the capacity to deliver 31 bcm of gas; this volume has been seriously reconsidered after two recent “gas wars” (2006 and 2009) with Ukraine. The expected present value of the South Stream system in terms of risks of transit interruptions through Ukraine is computed based on eq. (2). Figure 5 presents the expected NPV of South Stream investment under different scenarios of transit interruptions and demand growth in Europe.

Under the Base Case demand scenario and without any disruption the average NPV of the system is US\$ -4.3 bn. In the moderate disruption case, the expected additional NPV of the system, reflecting its expected security premium value, is US\$ 0.03 bn (i.e., -4.30-[-4.33]). Under the severe transit disruption scenario, the security value of the South Stream system would be US\$ 0.12 bn (i.e., -4.21-[-4.33]). South Stream’s expected security premium is rather marginal due to the effect of the operation of the Nord Stream pipeline. The Nord Stream pipeline will divert up to 50 bcm from Ukrainian pipelines and, therefore, Gazprom’s loss in cases of transit disruption through Ukraine is smaller.

If one is sure that there will definitely be five (ten) disruptions (i.e.,  $p_t=1, \forall t$ ) between 2011 and 2040, then South Stream’s security premium would be US\$ 0.06 bn (US\$ 0.24 bn). On the other hand, an expectation of no disruption through Ukraine between 2011 and 2040 (i.e.,  $p_t=0, \forall t$ ) results in no transit risks premium for South Stream.



**Figure 5:** Impact of Transit Interruptions on the NPV of the South Stream System

In general, in all scenarios of gas demand in Europe, ‘factoring’ in risks of transit interruptions through Ukraine would only improve the NPV of the South Stream system marginally and the system’s NPV would still be negative, which means that from Gazprom’s perspective transit risks do not justify the construction of the South Stream pipeline, as was suggested by the policy literature (see e.g., Finon, 2010).

It should be noted that the economic value of South Stream as the security of supply measure to European consumers might be substantially higher than Gazprom’s security value found in this analysis (Figure 5).<sup>21</sup> This is due to the fact that the economic costs of unserved energy (natural gas) to a particular country are substantially higher than the financial losses to Gazprom of not being able to export gas at market prices to that country when transit through Ukraine is interrupted.<sup>22</sup>

The preceding results show that only if gas demand in Europe grows at more than 2% per year up to 2030 will the NPV of the South Stream investment be positive, albeit marginally (about US\$ 1.1 bn over 25 years). However, that does not mean that there is no case for South Stream, only that the justification might largely rest on other considerations, which we will examine in the next section.

#### 6.4. Impact of Transit Fees on the Value of South Stream

In the preceding analysis it was assumed that the Ukrainian transit fee over time is determined according to the 2009 long-term transit contract (see Table 4); however, if Ukraine raises (reduces) its transit

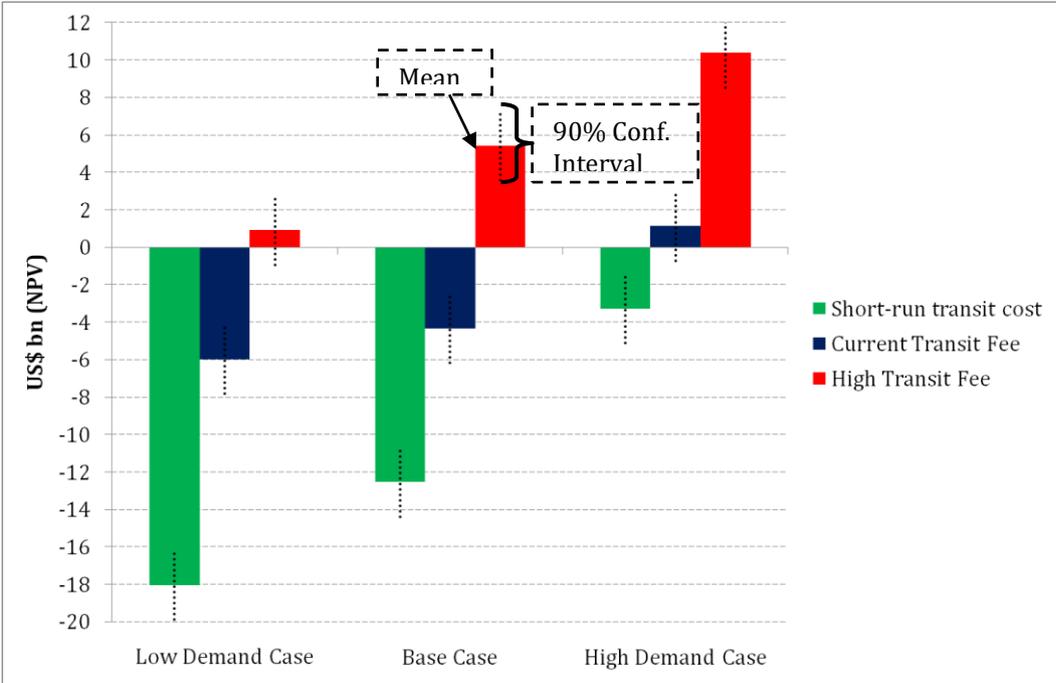
<sup>21</sup> A full social cost-benefit analysis of Nord Stream as security measure against transit interruptions is not subject of this research and it deserves a separate analysis.

<sup>22</sup> For example, the estimated economic costs of ‘unserved gas’ in the UK is in the range of £5/therm to £30/therm (DTI, 2006). Using an exchange rate of 1.6 USD/GBP, this range is equivalent to about US\$ 2900 to 17410/tcm.

fees, this will impact the cost efficiency of the South Stream pipeline compared to Ukrainian pipelines, and thus the NPV of the project may be positive (negative). This section examines this issue.

Using eq. (1) and the gas simulation model (Chyong and Hobbs, 2011), the NPV of Gazprom’s investment in South Stream is calculated according to different levels of transit fees (Table 4). Figure 6 reports the results of these calculations. The dotted lines show the impact of the project’s investment and O&M costs on South Stream’s NPV. Thus, if Ukraine sets its transit fee based on the short-run marginal cost (SRMC), then the average NPV of South Stream investment over its economic life varies between US\$ -18 bn and -3.3 bn, depending on the demand scenario in Europe. If Ukraine increases its transit to US\$ 5.11/tcm/100km, then the average NPV of South Stream would vary between US\$ 1 bn and 10 bn, depending on the assumed demand scenarios. Thus, Ukraine’s demand for economically justifiable transit fees makes South Stream investment profitable and Ukraine risks being completely bypassed under this scenario.

It is important to note that the average value of South Stream investment under the high demand and high transit fee scenarios (Figure 6: “red” bar, US\$ 10 bn) is nine times higher than its value under high demand but current transit fees (Figure 6: “blue” bar, US\$ 1.1 bn). This means, among other things, that the NPV of South Stream investment is much more sensitive to changes in Ukraine’s transit fee than to changes in gas demand in Europe.



**Figure 6:** Impact of Transit Fees on the NPV of South Stream

## 6.5. South Stream's Value in the Context of Russo-Ukrainian Gas Bargaining

In this section it is argued that South Stream's main value for Gazprom is in cementing its monopoly position in the Ukrainian gas market and keeping Ukraine's import price in line with European prices without risking its supplies to Europe.

In light of the threat of being completely bypassed by the Nord Stream (already under construction) and South Stream projects, the question of why one should ever consider a scenario in which Ukraine raises its transit fee, given that it is rather counterintuitive since the transit fee through Ukraine should be reduced, is legitimate.<sup>23</sup> Moreover, some experts argue that Ukraine cannot raise or change its transit fees until the expiration of the 2009 long-term transit contract in 2019. These concerns are addressed in turn.

As was argued for the case of the Nord Stream pipeline, once the pipeline is built, one may expect Ukraine to slash its transit fee downwards (see (Chyong et al., 2010)) to make its transit system as competitive as the Nord Stream route. However, this is not the case for South Stream, since the proposed pipeline system is not cost efficient compared to the Ukrainian system (see Section 6.1: Figures 2 and 3). To put this in the perspective of bargaining literature, whereas the Nord Stream pipeline is a credible threat, South Stream appears not to be a credible option for Gazprom to bypass Ukraine. The reasoning is that if a competitive pipeline system is more cost efficient than the Ukrainian system, that is, by building it, Gazprom can improve its profits, then the threat of building it is deemed credible and Ukraine should reduce its transit fee to accommodate Gazprom's demand (for a lower transit fee). This reasoning is based on the premise that both Gazprom and Ukraine are aware of the costs and benefits of using the existing transit system and also of the alternatives (South Stream). Thus, if Ukraine knows the costs and benefits of South Stream then, according to the results presented in Section 6.1, there is no economic reason for Ukraine to reduce its transit fees.

Existing transit and supply arrangements agreed between Russia and Ukraine in 2009 should, in principle, provide status quo equilibrium because contracts are legally binding documents *per se*.<sup>24</sup> However, these contracts do not guarantee that either Ukraine or Russia will not "defect" from the current arrangements.<sup>25</sup> The April 2010 agreement (more precisely - addendums to the 2009 contracts) is an

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<sup>23</sup> Pirani (2007): p.87) noted that Ukraine (or its leadership) is very sensitive concerning being bypassed by Gazprom.

<sup>24</sup> This should also have been true of previous contracts, particularly the transit contract signed in 2001 and the transit and supply arrangements of 2006. For details of the 2009 agreements see (Pirani et al., 2009)

<sup>25</sup> For example, Hubert and Ikonnikova (2003; 2004) and Hubert and Suleymanova (2008) have made a rather strong assumption concerning the lack of credibility of long-term commitments by transit countries, in particular Ukraine. For

evidence that even long-term contracts between Ukraine and Russia in the gas sector can be changed easily.<sup>26</sup> Also, Ukraine's perception of current gas arrangements (especially the supply contract) with Russia as "extremely unfavourable" deals renders the status quo equilibrium rather unstable in practice (Kovalko and Vitrenko, 2009a; Kovalko and Vitrenko, 2009b; Korrespondent.net, 2010).<sup>27</sup>

Therefore, the scenario of a high transit fee cannot be discarded, given South Stream's cost efficiency (see Section 6.1) and Ukraine's past behaviour and its willingness to re-contract its current gas arrangements with Russia. Moreover, in the context of current Russo-Ukrainian gas bargaining, this scenario can be interpreted as Ukraine bargaining over a lower import price, which, in the case of a bilateral monopoly, is equivalent to raising its transit fee (see Appendix B for details of the bargaining model showing the relationship between transit fees and import prices).<sup>28</sup>

Indeed, during 2005-2009, when gas prices in Europe rose substantially, Gazprom's implicit transit cost through Ukraine was also very significant. Figure 7 shows the economic value of South Stream as a function of Gazprom's implicit cost of transit under the base case demand assumption (calculations of the implicit transit cost and the derivation of South Stream's value as a function of the transit cost are presented in Appendix C). Gazprom's implicit cost of using Ukrainian transit pipelines includes the actual transit fee that Gazprom pays to Ukraine plus the opportunity cost of Gazprom's supplies to Ukraine at prices which are below European prices. This opportunity cost is attributed to Ukraine's transit monopoly and hence may be treated as part of the transit cost that Gazprom pays to Ukraine.<sup>29</sup>

As can be seen from Figure 7, South Stream's economic value will be significant if there are substantial discrepancies between European gas prices and the import price for Ukraine. For example, in 2006-2008, when the gas import price for Ukraine was about half the price paid to Gazprom by European

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example, Hubert and Suleymanova noted that since transit countries are sovereign states with national energy companies that are often strongly connected with the governments, and there is no truly independent legal system, national institutions offer little protection against opportunistic re-contracting (Hubert and Suleymanova, 2008).

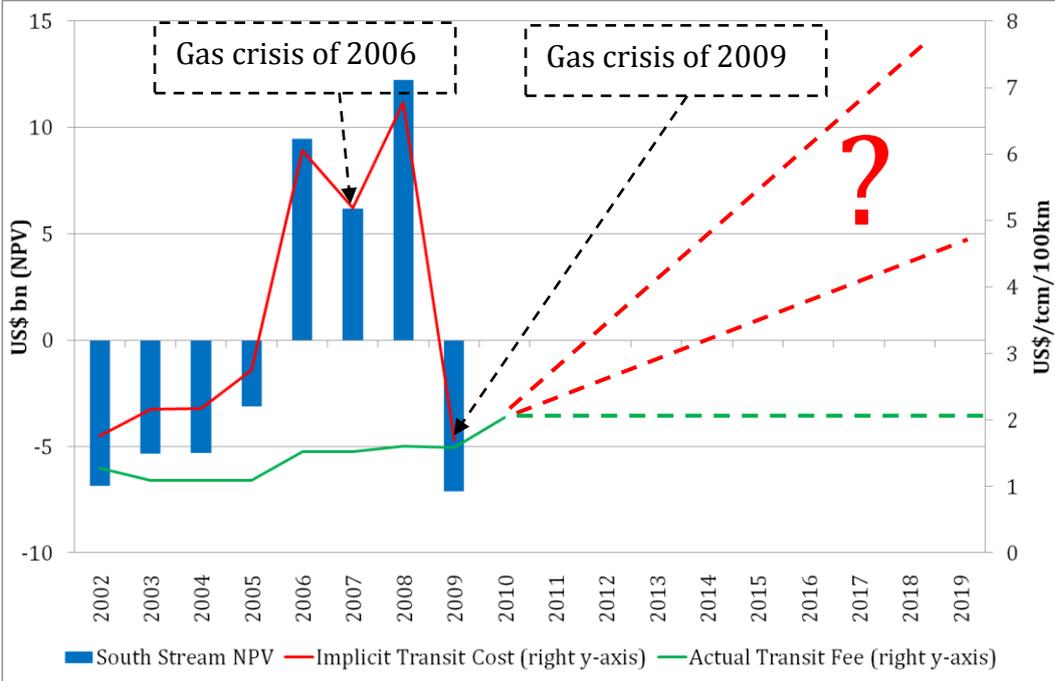
<sup>26</sup> The 2010 "Gas-Fleet" agreement, in which Russia granted a gas price discount of 30% from the price agreed in the 2009 long-term contract. The discount was granted in exchange for allowing Russia's naval fleet to remain in the Crimean peninsula until 2040. These developments call into question the stability of current gas transit and supply contracts, as these are now shown to involve not only economic considerations but also strategic-military issues. For details of the 2010 agreements see (Pirani et al., 2010).

<sup>27</sup> The Ukrainian Prime Minister Azarov was reported to have declared: "...we will not work with this agreement for 10 years" (Korrespondent.net, 2010). The supply contract was signed after the January 2009 gas dispute and is meant to last for 10 years.

<sup>28</sup> Russo-Ukrainian gas relations are characterized as a bilateral monopoly. On one side, Ukraine is a near monopolist in transporting Russian gas to Europe, while on the other side, Russia is a sole supplier of around two-thirds of the total annual gas consumption in Ukraine.

<sup>29</sup> Indeed, in 2003-2005 Gazprom supplied about 25 bcm per year to Ukraine in lieu of payment for Ukraine's transit services.

importers (see Appendix C: Table C.1), the value of South Stream would be US\$ 6-12 bn.<sup>30</sup> Since 2006, Gazprom has been consistently attempting to reduce the opportunity cost of transiting gas through Ukraine by equalizing the import price for Ukraine with the prices paid by its European customers.



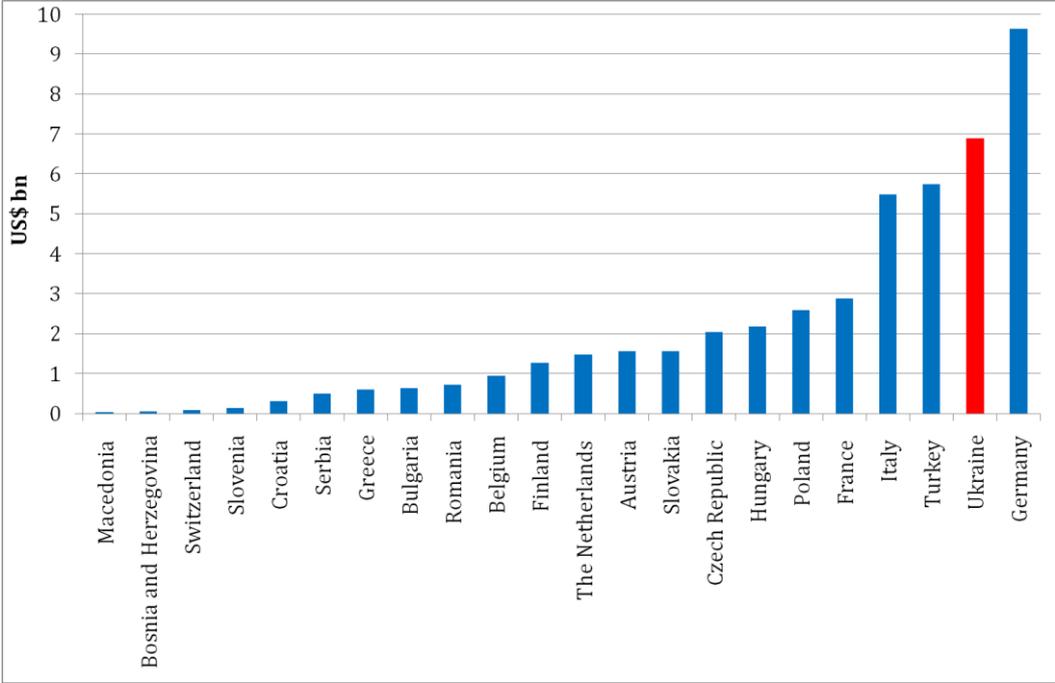
**Figure 7: South Stream’s Bargaining Value**

This strategy resulted in two transit disruptions (in 2006 and 2009), which badly hit Gazprom’s and Ukraine’s reputations as reliable gas suppliers; however, after the January 2009 gas crisis, Gazprom was able to completely eliminate the price differential and consequently the opportunity cost of transiting gas through Ukraine. Thus, in 2009 the value of Ukraine’s export market was the second largest in Gazprom’s export portfolio, just behind Gazprom’s traditional market – Germany (Figure 8). Therefore, South Stream investment is required to safeguard this value without risking its supplies to Europe; otherwise, Ukraine may bargain and reduce this value substantially.

To summarize, given the possibility that Ukraine may bargain over higher transit fees or lower import prices, it is expected that South Stream’s economic value will be derived primarily as insurance against Ukraine’s future bargaining. Without South Stream, Gazprom would be required to transport at least 60 bcm per year through Ukraine, depending on gas demand in Europe. Thus, viewed as insurance against such

<sup>30</sup> These values of US\$ 6-12 bn were calculated assuming that the decision to go ahead with the South Stream project was made in 2006-2008 under the base case gas demand and other assumptions as outlined in Section 5. For example, if Gazprom were to decide on the construction of South Stream in 2007 based on information about the cost and benefits of transiting through Ukraine in that year (2007), and assuming that the situation with Ukrainian transit would not change until 2032 (2007+25 years of life time of the South Stream pipeline), the NPV of South Stream evaluated in 2007 over 25 years would be about US\$ 6 bn.

opportunistic behaviour, South Stream investment has far greater value than insurance against risks of transit interruptions and/or as a demand-driven project.



**Figure 8:** Values of Gazprom’s Export Markets in 2009  
*Source: author’s calculations based on (Gazprom, 2010a; Pirani et al., 2010)*

**7. Conclusions**

South Stream’s project sponsors argue that the major objective of the pipeline is meeting additional demand for natural gas in Europe while eliminating transit risks (Gazprom, 2010b). Policy literature on South Stream also suggests that risks of transit disruptions through Ukraine may justify South Stream investment. However, it was shown in this analysis that transit risks do not justify the construction of the South Stream pipeline because under the scenarios of transit interruptions the economic value of South Stream is negative.

Concerning higher gas demand as a factor that justifies Gazprom’s investment in South Stream, it was found that only if demand in Europe grew at more than 2% p.a. up to 2030 would the economic value of this investment be positive, albeit rather marginally (US\$ 1.1 bn over 25 years). Although over the last twenty years gas demand in Europe has grown at more than 2% p.a., this growth rate is unlikely to be sustainable over the next twenty years (Noël, 2009). Moreover, there is a consistent view among experts that future

growth in gas demand in Europe is unlikely to be higher than 0.7% p.a. (that is the Base case analysed here).<sup>31</sup>

It was shown here that only if Ukraine increased its transit fee considerably, the economic value of South Stream investment would range between US\$ 1 bn and 10 bn, depending on assumed demand scenarios. Thus, as insurance against future bargaining from Ukraine, South Stream has far greater value than its value as insurance against transit interruptions and/or its value as a demand-driven project. The expert analysis and media commentary concerning Gazprom's investment in South Stream miss this important dimension. Gazprom's bypass strategy is not primarily about meeting future demand in Europe while eliminating transit risks. This strategy is about eliminating Ukraine's transit monopoly while preserving the value of Ukraine's gas market as high as possible without risking its gas supplies to Europe.

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<sup>31</sup> Particularly, in (IEA, 2009) the International Energy Agency forecasted EU's demand growth at 0.7% p.a.; the EC in (EC, 2008) expected its demand to grow at 0.6% p.a.; in November 2010, IEA revised its 2009 gas demand outlook downwards and projected that gas demand in the EU would grow at an annual growth rate of 0.4%; In a recent study by Honoré (2011), from the Oxford Institute for Energy Studies, gas demand in Europe is expected to grow at 0.6% p.a. until 2020.

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## Appendix A: The South Stream pipeline project

The assumed South Stream route is based on the recent publicly available project documentation from the developers (see Figure A.1 below) (South Stream AG, 2010). The exact capacities of the pipelines, which are part of the South Stream system, are not known yet. Therefore, the reported capacities here are assumptions (see Table A.1, below). The assumed start date of the South Stream system is 2016 (Gazprom, 2010b). It is assumed that, like the Nord Stream project, South Stream will be launched in stages. In 2016, half of the assumed capacity of each pipeline section of the system will be operational. The system's designed capacity (63 bcm) will be available from 2017.



**Figure A.1:** Assumed Route for the South Stream Pipeline System  
*Source: based on South-Stream.info*

**Table A.1:** South Stream Pipeline System

From	To	Number of lines	Capacity per line (bcm)	Total Capacity
<b>Offshore pipelines</b>				
Russia (Dzhubga)	Bulgaria (Varna)	4	15.75	63.00
Greece (Igoumenitsa)	Italy (Otranto)	2	10.00	20.00
<b>Onshore pipelines</b>				
Bulgaria (Varna)	Serbia (Zajecar)	2	21.50	43.00
Bulgaria (Varna)	Greece (Petrich)	1	20.00	20.00
Greece (Petrich)	Greece (Igoumenitsa)	1	20.00	20.00
Serbia (Zajecar)	Hungary (Subotica)	2	21.50	43.00
Hungary (Subotica)	Austria (Baumgarten)	1	21.50	21.50
Hungary (Subotica)	Slovenia	1	21.50	21.50
Slovenia	Austria (Arnoldstein)	1	21.50	21.50

## Appendix B: Russo-Ukrainian Gas Bargaining Game

Before Gazprom's "gas wars" with Ukraine, Russia used to supply gas for Ukrainian consumption at concessional prices, i.e. prices that were below European prices netted back to Ukraine. This appendix shows through the Nash bargaining model how concessional sales to Ukraine are connected with Ukraine's transit fees.

Suppose that the total surplus,  $\Pi^e$ , from Gazprom's sales to Europe transiting Ukraine totals:

$$\Pi^e = q^e(p^e - c_u - c_r) \quad (\text{B.1})$$

where  $q^e$  and  $p^e$  are Gazprom's gas sales and price to Europe,  $c_u$  is the marginal cost of gas transit through Ukraine, and  $c_r$  is the marginal production cost. Further, let  $\Pi^u$  be the total surplus from selling gas for Ukrainian consumption:

$$\Pi^u = q^u(p^* - c_r) \quad (\text{B.2})$$

where  $p^*$  is the alternative cost of meeting Ukraine's import demands,  $q^u$ ;  $p^*$  could be average price at a European hub, Norwegian price or Russian price at German border netted back to Ukraine.

Finally, let us denote the total surplus from the Russo-Ukrainian gas trade (transit plus supplies) as  $\Pi = \Pi^e + \Pi^u$  and say that Ukraine receives  $\pi_u$ , which maximizes

$$\max_{\pi_u} \text{NP} = \pi_u^\alpha (\Pi - \pi_u)^{(1-\alpha)} \quad (\text{B.3})$$

where NP is the Nash product,  $\alpha$  and  $(1-\alpha)$  are the Ukrainian and Russian bargaining powers, respectively, and  $(\Pi - \pi_u)$  is Russia's rent from exporting gas to Europe and Ukraine.

The maximization problem (B.3) implies that

$$\frac{d\text{NP}}{d\pi_u} = \left(\frac{\alpha\Pi}{\pi_u}\right) \left(\frac{\pi_u}{\Pi - \pi_u}\right)^\alpha = 0 \quad (\text{B.4})$$

and the solution to (B.4) is

$$\pi_u^* = \alpha\Pi = \alpha[q^e(p^e - c_u - c_r) + q^u(p^* - c_r)] \quad (\text{B.5})$$

which indicates that an efficient contract will charge opportunity costs for transit services,  $c_u$ , and gas supplies,  $c_r$ , with transit fees and/or import prices to transfer an appropriate share,  $\pi_u^*$ , of the total surplus,  $\Pi$ , to Ukraine. This share is proportional to its relative bargaining power vis-a-vis Russia ( $\alpha$ ).

Assuming that the relative bargaining power of each party does not change over time, Ukraine's rent in the gas trade,  $\pi_u$ , is increasing in: (i) the price of Russian gas in Europe,  $p^e$ , and (ii) the alternative cost of meeting Ukraine's import demand,  $p^*$ . Thus, as the alternative cost of meeting Ukraine's import demand,  $p^*$ , increases, Ukraine's share in the total rent,  $\pi_u$ , also rises. For Gazprom, this means that the opportunity cost of transporting gas through Ukraine raises substantially if the company does not break Ukraine's transit monopoly when  $p^*$  increases. This is because Gazprom's supplies to Ukraine could be sold under much higher prices in Europe than the price supplied to Ukraine due to its important position as a near transit monopolist.

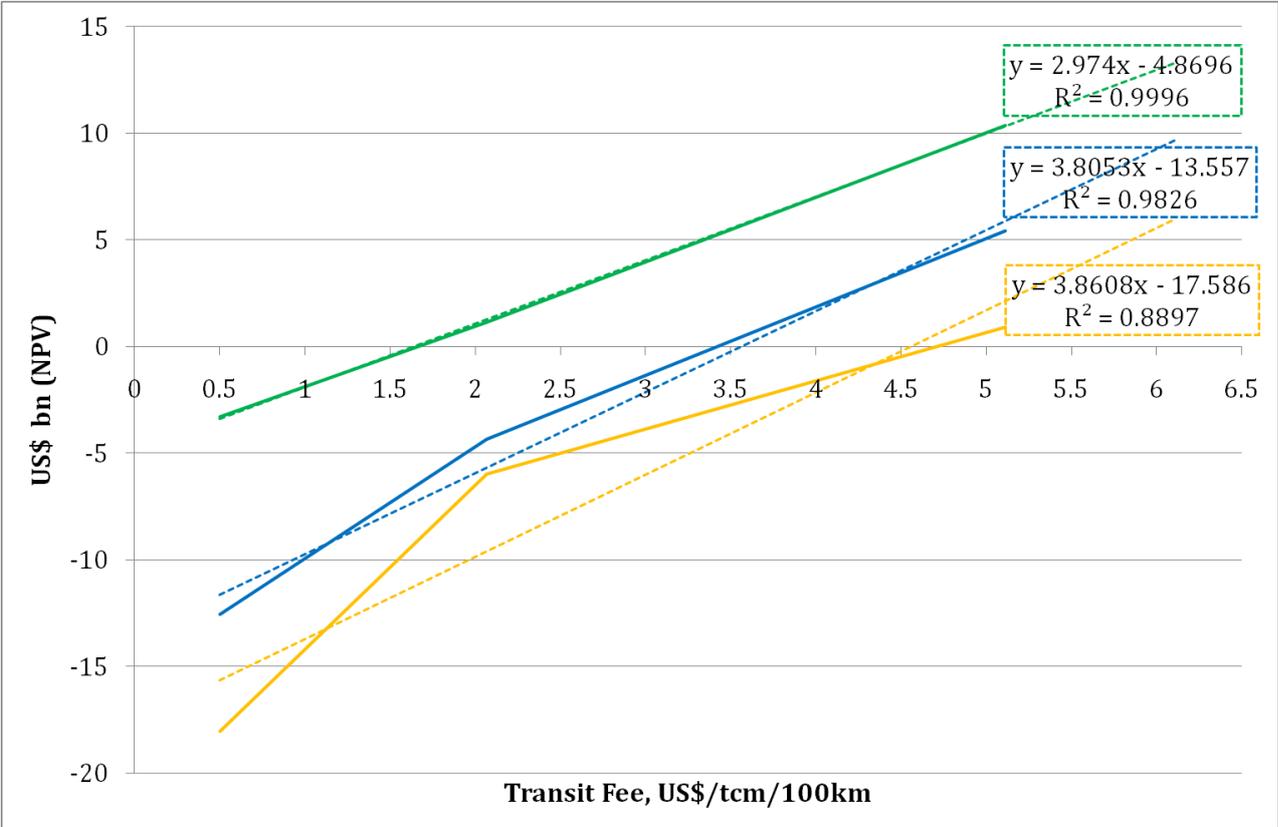
**Appendix C: Implicit Transit Costs through Ukraine**

**Table C.1: Deriving Gazprom’s Implicit Transit Costs through Ukraine**

	Actual Transit Fee	Transit volume	Actual Import Price	European Import Price	Import from Russia	Gazprom's Opportunity Cost	Implicit Transit Cost
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
2002	1.28	121	59	87	26	732	1.76
2003	1.09	129	50	116	26	1704	2.16
2004	1.09	137	50	126	24	1832	2.17
2005	1.09	136	50	171	23	2791	2.74
2006	1.53	129	95	228	54	7211	6.05
2007	1.52	115	130	234	50	5241	5.19
2008	1.61	120	180	335	49	7663	6.77
2009	1.58	96	233	237	30	135	1.70

Notes: [6]=[5]x([4]-[3]); [7]=[1]+([6]/[2]/D)x100; D – Transit Distance = 1240km  
 Columns: [1] and [7] are in US\$/tcm/100km; [2] and [5] are in billion cubic metres; [3] and [4] are in US\$/tcm; [6] is in US\$ mn  
 Sources: Own estimates based on various sources

For each demand scenario analysed, the NPV of South Stream investment was derived under three different values of transit fees, as indicated in Table 4 (Section 5). Then, the NPV of South Stream as a function of transit fees through Ukraine under the three demand scenarios are approximated using a simple linear regression, as shown in Figure C.1.



**Figure C.1: Dependence between South Stream’s Value and Transit Fees through Ukraine**