A Appendix

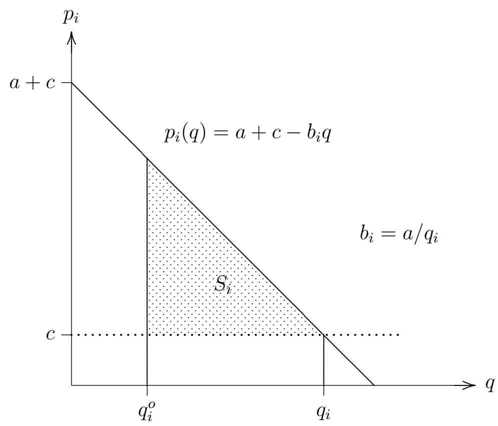
A.1 Calibration

This appendix describes the functions and parameters used for the calculation of the value function (equation (1) in the main text). Let f^*_{ij}, $\{i, j\} \in L(N)$ denote the solution to the program in (1) when solved for the grand coalition, which has access to all resources. To calibrate the model, p_i and T_{ij} have to be determined such that f^*_{ij} are reasonably close to observed consumption and flows. As it is assumed that the players cooperate effectively, they will make efficient use of the existing network. Hence, for each player the marginal willingness to pay for gas, $p_i(q)$ will be equal to the local marginal cost of supplying gas, i.e., the nodal cost $c_i(q)$, which takes into account the physical constraints of the system. This feature is used to calibrate first inverse demand and then supply cost using data on consumption and flows.

Demand

Transport costs within Europe are small compared to the cost of producing gas and transporting it to Europe's borders. As a first approximation, the small differences among local costs are neglected, and a common constant supply cost c is assumed. When the program is solved for the grand coalition, none of the links within Europe are capacity constrained. So, nodal costs differ only by the variable transportation cost between connected nodes which are small.

Figure 2: The Surplus (S_i)



We assume a quadratic utility function so that each consumption node's willingness to pay for gas is represented with a linear inverse demand function. To reduce the number of parameters, for all consumption nodes the same intercept $a+c$ is assumed. Efficiency requires $p_i(q) = a+c-b_iq = c$ for each consumption node i. The slope parameters b_i are then calibrated as to replicate the consumption in 2009: $b_i = a/q_i$, where q_i is the consumption of gas

Table 4: Consumption

Consumption nodes	Consumption[a] [bcm/a] q_i	Slope Baseline $a = 1500$ b_i	Low surplus $a = 500$ b_i	Needed for access
AzerbaijanC	10,	150	50	Azerbaijan
BelarusC	17.9	83.9	28.	Belarus
IranC	136.5	11.	3.7	Iran
KazakhstanC	22.9	65.6	21.9	Turkmenistan[b]
RussiaC	426.4	3.5	1.2	Russia
TurkeyC	36.4	41.2	13.7	Turkey
TurkmenistanC	18.6	80.6	26.9	Turkmenistan
UkraineC	53.3	28.1	9.4	Ukraine
UzbekistanC	51.8	29.	9.7	Turkmenistan
BalkanC	20.2	74.3	24.8	Balkan
BelgiumC	16.9	88.9	29.6	Belgium
CenterC	104.6	14.3	4.8	Center
Center-EastC	41.4	36.2	12.1	Center-East
FranceC	44.1	34.	11.3	France
ItalyC	75.6	19.8	6.6	Italy
NetherlandsC	48.3	31.1	10.4	Netherlands
PolandC	16.	93.8	31.3	Poland
UKC	90.5	16.6	5.5	UK

[a]Data for consumption in 2009 are compiled from IEA (2010) and IEA (2011).

[b]To reduce the number of players, Turkmenistan stands for Kazakhstan, Uzbekistan, and itself.

in the consumption node i. As illustrated in Figure 2, the surplus, which a player obtains from participating in the trade of pipeline gas, depends on three parameters: the difference between the demand intercept and the common supply cost a, its consumption in the base year q_i, and its indigenous production q_i^o. The common supply cost c acts as a shift parameter, which does not affect the surplus.

A change of a, with b_i being adjusted, affects all players proportionally. Such a change has little impact on the *relative* Shapley value (measured in percent of the total), hence, will have little effect on the relative index for bargaining power. However, a determines the absolute size of the surplus and thus, the *absolute* Shapley value, which is of relevance if the changes in bargaining power are compared to the cost of a pipeline project. It is difficult to support any assumption for a by hard data. Obviously, it will depend a lot on how much time customers are given to substitute to other sources of energy. Making a bold assumption, in the baseline variant a is set equal to 1500 mn €/bcm yielding a total surplus from consuming gas of 949.9 bn €/a. To check the robustness of the results, a 'low-surplus' scenario with $a = 500$ mn €/bcm is considered as well. In this case, the total surplus decreases to 334.3 bn €/a. Table 4 presents the resulting values of the slope parameter b_i depending on a. All quantities are quoted in bcm/a. All prices or costs are quoted in mn €/bcm, giving the same figure as the more common €/tcm.

The parameter c acts as a shift parameter for the demand system and supposed to reflect the typical production and the transportation cost. Accordingly, it is decomposed as $c = c^P + \bar{c}^T$, where c^P reflects a common production cost parameter and $\bar{c}^T$ an adjustment made for typical transportation cost. These values determine the patterns of production and transport which are presented next.

Production

Table 5 presents the players' production capacities, production volumes as well as production costs. The production volumes in 2009 are collected from IEA (2010) and IEA (2011). For the players except Russia and Turkmenistan the production capacities are assumed equal to their production volumes in 2009.

The differences in the production cost of existing fields are small compared to differences in the cost of developing new fields. Since meaningful information on wellhead production cost is difficult to obtain, a common supply cost parameter c^P is introduced. In accordance with Table 13.6 in IEA (2009), Δ_i accounts for regional differences in wellhead production cost and adjusts c^P for each player. For the players, who are net importers, cost of using their indigenous production is ignored. Since it is more difficult to produce at maximal capacity k_{ij}, production cost is assumed to be piecewise linear : $T_{ij}(f) = (c^P + \Delta_i)(\min[f, 0.75 * k_{ij}] + 1.2 \max[f - 0.75 * k_{ij}, 0])$. These adjustments help to get more realistic flows for the network, but have only a negligible impact on the estimate of bargaining power. Since the demand system is adjusted to any choice of c^P, its absolute value is rather irrelevant and arbitrarily set as $c^P = 20$ mn €/bcm.

Transport

The total cost of transporting gas consists of, in principle, operating cost and capacity cost. Since capacity costs of existing pipelines are sunk, they are not taken into account. This simplification is based on the assumption that bargaining among rational players should not be influenced by sunk cost. The operating

Table 5: Pipeline network: production

Links from	Links to	Capacity k_{ij} [bcm/a]	Flow [bcm/a]	Cost[a] $c_p + \Delta_i$ [€/tcm]	needed for access
Net Exporters					
AzerbaijanP	Azerbaijan	14.9[b]	14.9	$c_p - 5$	Azerbaijan
IranP	Iran	137.4[c]	137.4	$c_p - 16$	Iran
IraqP	Iraq	1.1[d]	1.1	$c_p - 8$	Iraq
KazakhstanP	Kazakhstan	27.2	27.2	$c_p + 1$	Turkmenistan[e]
NorwayP	Norway	99.4	99.4	$c_p - 7$	Norway
RussiaP	Russia	650.8	550.5	c_p	Russia
TurkmenistanP	Turkmenistan	70.9	38.3	$c_p + 3.4$	Turkmenistan
UzbekistanP	Uzbekistan	65.6	65.6	$c_p + 1$	Turkmenistan
NetherlandsP	Netherlands	78.7	78.7	$c_p - 4.4$	Netherlands
Net Importers					
BalkanP	Balkan	10.8	10.8	0.	Balkan
BelarusP	Belarus	0.2	0.2	0.	Belarus
BelgiumP	Belgium	0.	0.	0.	Belgium
CenterP	Center	23.7	23.7	0.	Center
Center-EastP	Center-East	4.8	4.8	0.	Center-East
FranceP	France	0.9	0.9	0.	France
ItalyP	Italy	8.1	8.1	0.	Italy
PolandP	Poland	5.8	5.8	0.	Poland
TurkeyP	Turkey	0.7	0.7	0.	Turkey
UKP	UK	62.1	62.1	0.	UK
UkraineP	Ukraine	21.9	21.9	0.	Ukraine

[a] The global parameter c_p is set equal to 20. Production cost of the players, who are net importers, is set equal to zero. The unit cost is given for flows up to 75% of the capacity. For the remaining 25% of capacity the numbers are increased by 20%.

[b] The Shah Deniz II field will increase Azerbaijan's current production capacity by 16 bcm/a and serve Nabucco.

[c] Investment in Iran's South Pars field will supply an additional 15 bcm/a to Nabucco.

[d] Northern Iraqi fields will produce an other 10 bcm/a to fill Nabucco's large capacities.

[e] To reduce the number of players, Turkmenistan stands for Kazakhstan, Uzbekistan and itself.

cost is composed by management & maintenance cost and energy cost, which are proportional to the length of the pipeline as well as to the quantity of gas transported. The operating cost is represented as a piecewise linear function: $T_{ij}(f) = c^T_{ij} * (\min[f, 0.75 * k_{ij}] + 1.2 * \max[f - 0.75 * k_{ij}, 0])$, where k_{ij} denotes maximal capacity. Per unit transportation costs are constant, but only up to three quarter of the pipe capacity and increased by 20% for the remaining quarter. Capacities of the pipelines linking the players' transit nodes are collected from ENTSOG (2010) and public sources. Flows in 2009 are compiled from IEA (2010) and IEA (2011). Capacities of the pipelines which are connected to areas outside of the regional scope are limited to flows through them in 2009. The pipeline capacities and the flows through them are presented in the first two columns of Tables 6 and 7.

To calculate the link specific cost parameter c^T_{ij}, for onshore pipelines universal operating cost of 0.3 mn €/bcm/100km is assumed. For offshore pipelines operating cost is 50% higher to account for higher pressure and increased difficulties of maintenance. These coefficients are then multiplied with the distance between the nodes to obtain the link specific operating cost as shown in column 3 of Table 6 and 7.

Having specified the production cost by c^P and Δ_i, as well as the link specific transportation cost by c^T_{ij}, the only free parameter is the 'typical' transport cost $\bar{c}^T$. To determine a value, the optimization program (1) is run for the grand coalition to find that $\bar{c}^T = 19$ mn €/bcm yields a solution f^*_{ij} which closely replicates the empirical data on consumption and flows in the system.

Table 6: Pipeline network A

Links from	Links to	Capacity [bcm/a]	Flow [bcm/a]	Operation[a] Cost: c^T_{ij} [mn €/bcm]	Needed for access
Transit outside EU					
Azerbaijan	RussiaS	13.	0.	3.8	Azerbaijan, Russia
Azerbaijan	TurkeyE	7.	4.5	2.4	Azerbaijan, Turkey
Iran	TurkeyE	13.7	7.2	1.2	Iran, Turkey
Iraq	TurkeyE	0.	0.	1.7	Iran, Turkey
Kazakhstan	Russia	49.	0.	5.1	Russia, Turkmenistan[b]
Kazakhstan	RussiaS	49.	32.3	3.6	Russia, Turkmenistan
Russia	Belarus	100.	49.2	2.1	Russia, Belarus
Russia	RussiaN	165.	0.	2.3	Russia
Russia	RussiaS	240.	8.9	2.1	Russia
Russia	UkraineE	415.	109.1	2.	Russia, Ukraine
RussiaN	Center	0.	0.	6.9	Russia
RussiaS	Turkey	16.	8.9	4.8	Russia, Turkey
RussiaS	UkraineE	200.	24.6	1.2	Russia, Ukraine
TurkeyE	Turkey	20.	11.8	2.4	Turkey
Turkmenistan	Iran	20.	5.8	2.3	Turkmenistan, Iran
Turkmenistan	Kazakhstan	5.	0.	2.7	Turkmenistan
Turkmenistan	Uzbekistan	44.	10.7	1.7	Turkmenistan
UkraineE	Ukraine	122.	95.1	2.5	Ukraine
Uzbekistan	Kazakhstan	44.	22.5	1.8	Turkmenistan

[a] The unit cost is given for flows up to 75% of the capacity. For the remaining 25% of capacity the numbers are increased by 20%.

[b]To reduce the number of players, Turkmenistan stands for Kazakhstan, Uzbekistan and itself.

Table 7: Pipeline network B

Links from	Links to	Capacity [bcm/a]	Flow [bcm/a]	Operation[a] Cost: c^T_{ij} [mn €/bcm]	Needed for access
Transit into (out of) EU					
Balkan	Turkey	16.3	8.9	1.8	Turkey
Belarus	Poland	33.	31.3	1.4	Belarus
Norway	Belgium	15.	12.2	5.2	Norway
Norway	France	18.2	15.	5.9	Norway
Norway	Center	46.	29.2	5.2	Norway
Norway	UK	46.4	24.	4.9	Norway
UkraineE	Balkan	31.3	16.5	3.4	Ukraine
Ukraine	Center-East	105.8	77.	1.9	Ukraine
Ukraine	Poland	3.2	3.2	1.2	Ukraine
Transit within EU					
Belgium	France	30.	14.9	0.8	Free third party access to transit pipelines within the EU
Belgium	Center	26.	1.	0.6	
Center-East	Balkan	1.7	1.	3.3	
Center-East	Center	77.8	18.4	2.4	
Center-East	Italy	37.	21.3	2.7	
Center	France	28.	4.3	1.4	
Center	Italy	20.2	9.1	3.5	
Netherlands	Belgium	53.	10.7	0.5	
Netherlands	Center	80.	11.7	0.6	
Netherlands	UK	15.3	7.	1.	
Poland	Center	31.4	24.4	3.2	
UK	Belgium	25.5	7.5	1.5	
Out of Regional Scope					
Algeria	Italy	25.4	25.4	6.2	Italy
France	Iberia	1.1	1.1	3.2	France
Libya	Italy	9.	9.	4.7	Italy

[a] The unit cost is given for flows up to 75% of the capacity. For the remaining 25% of capacity the numbers are increased by 20%.

LNG

In the model the LNG gas is considered as nonstrategic since a single LNG exporter's market share in the Eurasian gas trade is small relative to the market power of the suppliers of the pipeline gas. Incorporation of the global LNG market into a cooperative game would be challenging. Since the LNG gas is a common source so that actions of players outside of the considered coalition would have to be taken into account. They will form alternative coalitions which may tap the LNG market and change the availability of the LNG supplies. Since the focus of the paper is on pipeline gas, the LNG market is not modeled explicitly.

The LNG regasification plants, also called terminals, are represented as LNG

Table 8: Pipeline network: LNG regasification plants

Links from	Links to	Capacity [bcm/a]	Flow [bcm/a]	Cost[a] $c_p + \Delta_i$ [mn €/bcm]	needed for access
BalkanLNG	Balkan	0.8	0.8	$2c_p$	Balkan
BelgiumLNG	Belgium	3.	3.	$2c_p$	Belgium
FranceLNG	France	10.1	10.1	$2c_p$	France
CenterLNG	Center	0.	0.	$2c_p$	Center
ItalyLNG	Italy	2.9	2.9	$2c_p$	Italy
NetherlandsLNG	Netherlands	0.	0.	$2c_p$	Netherlands
PolandLNG	Poland	0.	0.	$2c_p$	Poland
TurkeyLNG	Turkey	6.1	6.1	$2c_p$	Turkey
UKLNG	UK	10.1	10.1	$2c_p$	UK

[a]The global parameter c_p is set equal to 20. The unit cost is given for flows up to 75% of the capacity. For the remaining 25% of capacity the numbers are increased by 20%.

links with capacities limited to flow in 2009. The LNG regasification capacities and imports through them are compiled from GIE (2010), IEA (2010) and IEA (2011). Comparing Tables 13.5 and 13.6 in IEA (2009), the total cost (sum of production, liquefaction, transportation and regasification costs) of gas which is imported through the LNG terminals is assumed as $2c^P$. Similar to the production and transportation costs, total cost of LNG is assumed to be piecewise linear : $T_{ij}(f) = 2c^P(\min[f, 0.75 * k_{ij}] + 1.2 \max[f - 0.75 * k_{ij}, 0])$. Figures for the LNG links are given in Table 8.

New Projects

Information about the pipeline projects is obtained from various public sources. Cost estimates of the project consortia are supplemented by own estimates if figures are unavailable, outdated or subject to review. A rather high discount rate of 15% is used to translate capital expenditures into annualized capacity cost. This rate is a common hurdle rate in the gas industry and reflects the real option nature of the investment and depreciation. Table 9 collects the parameters for the new pipelines.

Table 9: Pipeline network: new pipelines

Links from	Links to	Capacity[a] old + new [bcm/a]	Flow[b] [bcm/a]	Operation Cost [€/tcm]	Capacity Cost [bn €]	required for for access
Nord Stream						
RussiaN	Center	0 + 55	0	6.9	12	Russia
South Stream						
RussiaS	Balkan	0 + 63	0	5.6	8.6	Russia
Center-EastSS	BalkanSS[c]	1.7 + 30	0.	3.3	3.5	Russia
Balkan	Italy	0 + 10	0	3.9	3.4	Russia
Nabucco						
Turkmenistan	Azerbaijan[d]	0 + 30	0	0.9	2.3	Azerbaijan, Turkmenistan
Azerbaijan	TurkeyE	8.8 + 45	4.5	2.4	7.5	Azerbaijan, Turkey
Iran	TurkeyE	13.7 + 15	7.2	1.2	5.4	Iran, Turkey
Iraq	TurkeyE	0 + 10	0	1.7	1.2	Iraq, Turkey
TurkeyE	Turkey	20 + 30	11.8	2.4	2.5	Turkey
Balkan	Turkey[e]	16.3 + 30	8.9	1.8	1.9	Turkey
Center-East	Balkan[c]	1.7 + 30	1	3.3	3.5	-

[a] Existing capacity as compiled from ENTSOG (2010) and public sources + planned capacity.

[b] Data are compiled from IEA (2010) and IEA (2011).

[c] Currently gas flows from Center-East to Balkan. The projects plan to revert the flow.

[d] This part of the project is referred to as Trans-Caspian.

[e] Currently gas flows from Balkan to Turkey. The project plans to revert the flow.

A.2 Robustness

The results reported in the main text depend on a number of parameter assumptions and we will briefly discuss, how robust they are. All tables are given in appendix A.3.

Demand Intercept and Surplus

The power index, as measured by the relative Shapley Value, depends largely on the architecture of the current network and access rights and it is quite robust with respect to a proportional change of surplus in all regions or a uniform modification of production cost of all suppliers. Our conclusion about the strategic viability of additional pipelines, however, compares absolute cost to absolute gains. To check robustness we reduced the surplus by uniformly decreasing the demand intercept for the customers down to one third of its original value (500 mn €/bcm) while adjusting the slope to replicate consumption in the reference year (see tables 10-12.). Less pipelines and pipeline sections are strategically viable, but the relative merits of the different projects do not change much. The benefit to cost ratio remains by far highest for Nord Stream, from the perspective of both, the respective consortium and the EU. For the EU Nabucco has the lowest benefit to cost ratio while South Stream remains the least attractive proposition for its consortium.

Our conclusions derived from the absolute and relative nucleolus are robust with respect to the reduction in surplus. Nord Stream and South Stream alter the power structure barely, and gains accruing from Nabucco to its consortium falls short to cover the project's large cost (see tables 16-18.).

Access Right Regime

Next, we reconsider our assumption of free third party access within the EU. When the EC started its policies to ensure a common market for natural gas in the late nineties, the situation was indeed very different. Most countries had a 'national champion' who monopolized the high pressure transportation grid, hence long distance transport, and one might argue that it is still a long way to overcome this fragmentation of the market. In a fragmented market, a region in the EU enjoys exclusive access to its trunk-pipes and can derive bargaining power by blocking gas shipments. As a rule, the European regions, which neighbor a producer or a transit country, gain transit power while importers without Non-European borders suffer in a fragmented market compared to an integrated one (see Hubert and Orlova (2014a) for a detailed analysis).

The impact of a change in the access right regime on the power structure is quite substantial. When assessed with the Shapley value, Nord Stream has still the highest benefit to cost ratio for its consortium, but the impact on the European regions is heterogeneous. The regions in Eastern Europe are being harmed. Hence, we cannot conclude that the project is a common European interest. Benefits accruing from South Stream to its consortium doubles, barely covering the project's cost, but in the EU, the largest consumer Center, encounters losses. Nabucco is still the least attractive project for the EU. Turkey shares its large gains with the European members of its consortium, but Center loses power although it was one of the initiators of the project (see tables 19-21.).

The nucleolus is still in stark contrast with the Shapley value. In a fragmented European market Nord Stream and Nabucco have some strategic value while South Stream has again a minute impact on the power structure. Nord Stream alters the power structure significantly. The project is strategically viable for the EU, but not for its respective consortium since large losses accrue to Russia, the initiator of the project. Nabucco brings larger benefits to the members of its consortium, but in total their gains are still lower than the project's cost (see tables 22-24.).

A.3 Tables for Robustness

Decreased Demand (Surplus) : Shapley Value

Table 10: Nord Stream, Shapley Value, Decreased Demand

Players	Shapley value [%] without Nord Stream	Shapley value [%] with Nord Stream	Shapley value [%] difference
Russia	13.	16.	3.
Ukraine	9.3	6.9	−2.4
Belarus	6.6	5.8	−0.8
Norway	14.	11.6	−2.4
Netherlands	6.2	5.3	−0.9
UK	2.	2.	0.
Center	16.2	17.6	1.4
Center-East	8.6	9.3	0.7
Italy	3.	3.3	0.3
Poland	1.6	1.8	0.2
France	6.5	7.1	0.6
Belgium	3.	3.3	0.3
Balkan	0.8	0.8	0.
Turkey	7.4	7.3	0.
Iraq	0.	0.	0.
Iran	1.	1.	0.
Azerbaijan	0.6	0.5	0.
Turkmenistan	0.2	0.2	0.

Table 11: South Stream, Shapley Value, Decreased Demand

	without Nord Stream		*with Nord Stream*			
	Shapley value [%]	Impact[a] OS, NW, SW	Shapley value [%]	Impact of pipeline sections[b] OS	OS, NW	OS, NW, SW
Russia	15.9	2.8	16.8	0.3	0.8	0.8
Ukraine	6.9	−2.4	6.	−0.3	−0.8	−0.9
Belarus	5.9	−0.7	5.6	0.	−0.2	−0.2
Norway	12.1	−2.	11.1	0.	−0.5	−0.6
Netherlands	5.5	−0.7	5.1	0.	−0.2	−0.2
UK	1.9	0.	2.	0.	0.	0.
Center	17.3	1.1	18.1	0.	0.4	0.5
Center-East	9.2	0.6	9.5	0.	0.2	0.2
Italy	3.3	0.3	3.4	0.	0.1	0.1
Poland	1.8	0.1	1.8	0.	0.	0.
France	7.	0.5	7.3	0.	0.1	0.2
Belgium	3.3	0.2	3.4	0.	0.1	0.1
Balkan	1.	0.2	1.	0.2	0.2	0.2
Turkey	7.4	0.	7.4	0.1	0.1	0.1
Iran	0.9	−0.1	0.9	−0.1	−0.1	−0.1
Azerbaijan	0.5	−0.1	0.5	−0.1	−0.1	−0.1
Turkmenistan	0.2	0.	0.2	0.	0.	0.

[a]difference to column 1 table 10

[b]difference to column 2 table 10

Table 12: Nabucco, Shapley Value, Decreased Demand

	without South Stream				*with South Stream*	
	Shapley value [%]	Impact of pipeline sections[a] TC, ES	WS	TC, ES, CS, WS	Shapley value [%]	Impact[b] TC, ES, CS, WS
Russia	13.	−2.3	−0.1	−3.1	13.5	−3.3
Ukraine	6.2	−0.1	−0.5	−0.7	5.6	−0.4
Belarus	5.7	0.	0.	−0.1	5.5	0.
Norway	10.8	−0.5	0.3	−0.8	10.3	−0.7
Netherlands	5.	−0.2	0.1	−0.3	4.8	−0.3
UK	1.9	0.	0.	−0.1	1.9	−0.1
Center	17.8	0.	−0.1	0.2	18.3	0.2
Center-East	9.4	0.	0.	0.1	9.6	0.1
Italy	3.3	0.	0.	0.	3.5	0.
Poland	1.8	0.	0.	0.	1.9	0.
France	7.2	0.	0.	0.1	7.3	0.1
Belgium	3.4	0.	0.	0.	3.4	0.
Balkan	1.1	0.1	0.2	0.2	1.1	0.1
Turkey	10.3	1.9	0.6	2.9	10.1	2.7
Iraq	0.4	0.5	0.	0.4	0.4	0.4
Iran	1.1	0.	−0.2	0.1	1.	0.2
Azerbaijan	1.3	0.6	−0.1	0.8	1.3	0.8
Turkmenistan	0.4	0.	0.	0.1	0.4	0.1

[a]difference to column 2 table 10

[b]difference to column 3 table 11

A.4 Tables for the Nucleolus

The following tables (13 to 15) give the results for the nucleolus. They correspond to tables 1 to 3 in the main text. The results are discussed in section 4.

Table 13: Nord Stream, Nucleolus

Players	Nucleolus [%]		
	without Nord Stream	with Nord Stream	difference
Russia	0.8	0.8	−0.1
Ukraine	8.5	8.4	0.
Belarus	7.9	7.9	0.
Norway	1.2	1.2	0.
Netherlands	0.4	0.4	0.
UK	1.7	1.7	0.
Center	28.1	28.2	0.
Center-East	14.5	14.5	0.
Italy	5.4	5.4	0.
Poland	2.9	2.9	0.
France	11.2	11.2	0.
Belgium	5.1	5.1	0.
Balkan	1.5	1.5	0.
Turkey	10.8	10.8	0.
Iraq	0.	0.	0.
Iran	0.	0.	0.
Azerbaijan	0.	0.	0.
Turkmenistan	0.	0.	0.

Table 14: South Stream, Nucleolus

	without Nord Stream		*with Nord Stream*			
	Nucleolus [%]	Impact[a] OS, NW, SW	Nucleolus [%]	Impact of pipeline sections[b] OS	OS, NW	OS, NW, SW
Russia	0.8	0.	0.8	0.	0.	0.
Ukraine	8.4	0.	8.4	0.	0.	0.
Belarus	7.9	0.	7.9	0.	0.	0.
Norway	1.2	0.	1.2	0.	0.	0.
Netherlands	0.4	0.	0.4	0.	0.	0.
UK	1.7	0.	1.7	0.	0.	0.
Center	28.1	0.	28.2	0.	0.	0.
Center-East	14.5	0.	14.5	0.	0.	0.
Italy	5.4	0.	5.4	0.	0.	0.
Poland	2.9	0.	2.9	0.	0.	0.
France	11.2	0.	11.2	0.	0.	0.
Belgium	5.1	0.	5.1	0.	0.	0.
Balkan	1.5	0.	1.6	0.	0.	0.
Turkey	10.8	0.	10.8	0.	0.	0.
Iran	0.	0.	0.	0.	0.	0.
Azerbaijan	0.	0.	0.	0.	0.	0.
Turkmenistan	0.	0.	0.	0.	0.	0.

[a]difference to column 1 table 13

[b]difference to column 2 table 13

Table 15: Nabucco, Nucleolus

	without South Stream				*with South Stream*	
	Nucleolus [%]	Impact of pipeline sections[a] TC, ES	WS	TC, ES, CS, WS	Nucleolus [%]	Impact[b] TC, ES, CS, WS
Russia	0.6	−0.2	−0.1	−0.2	0.6	−0.2
Ukraine	8.3	−0.1	0.	−0.1	8.3	−0.1
Belarus	7.9	0.	0.	0.	7.9	0.
Norway	1.2	0.	0.	0.	1.2	0.
Netherlands	0.4	0.	0.	0.	0.4	0.
UK	1.7	0.	0.	0.	1.7	0.
Center	28.	−0.1	0.	−0.1	28.	−0.1
Center-East	14.5	−0.1	0.	−0.1	14.4	−0.1
Italy	5.4	0.	0.	0.	5.4	0.
Poland	2.9	0.	0.	0.	2.9	0.
France	11.1	0.	0.	−0.1	11.1	−0.1
Belgium	5.1	0.	0.	0.	5.1	0.
Balkan	1.6	0.1	0.1	0.1	1.6	0.1
Turkey	11.1	0.3	0.1	0.3	11.1	0.3
Iraq	0.	0.	0.	0.	0.	0.
Iran	0.1	0.1	0.	0.1	0.1	0.1
Azerbaijan	0.1	0.1	0.	0.1	0.1	0.1
Turkmenistan	0.	0.	0.	0.	0.	0.

[a] difference to column 2 table 13

[b] difference to column 3 table 14

Decreased Demand (Surplus) : Nucleolus

Table 16: Nord Stream, Nucleolus, Decreased Demand

Players	Nucleolus [%] without Nord Stream	with Nord Stream	difference
Russia	2.2	2.1	−0.1
Ukraine	8.3	8.2	−0.1
Belarus	7.6	7.6	0.
Norway	3.5	3.4	−0.1
Netherlands	1.1	1.	0.
UK	1.6	1.6	0.
Center	26.8	26.9	0.1
Center-East	13.8	13.9	0.
Italy	5.	5.1	0.
Poland	2.8	2.8	0.
France	10.6	10.7	0.
Belgium	4.9	4.9	0.
Balkan	1.2	1.3	0.1
Turkey	10.2	10.2	0.
Iraq	0.	0.	0.
Iran	0.1	0.1	0.
Azerbaijan	0.1	0.1	0.
Turkmenistan	0.1	0.1	0.

Table 17: South Stream, Nucleolus, Decreased Demand

	without Nord Stream		*with Nord Stream*			
	Nucleolus [%]	Impact[a] OS, NW, SW	Nucleolus [%]	Impact of pipeline sections[b] OS	OS, NW	OS, NW, SW
Russia	2.2	0.	2.1	0.	0.	0.
Ukraine	8.2	−0.1	8.1	−0.1	−0.1	−0.1
Belarus	7.6	0.	7.6	0.	0.	0.
Norway	3.5	0.	3.4	0.	0.	0.
Netherlands	1.1	0.	1.	0.	0.	0.
UK	1.6	0.	1.6	0.	0.	0.
Center	26.8	0.	26.9	0.	0.	0.
Center-East	13.8	0.	13.9	0.	0.	0.
Italy	5.1	0.	5.1	0.	0.	0.
Poland	2.8	0.	2.8	0.	0.	0.
France	10.6	0.	10.7	0.	0.	0.
Belgium	4.9	0.	4.9	0.	0.	0.
Balkan	1.3	0.1	1.3	0.	0.	0.
Turkey	10.2	0.	10.3	0.	0.	0.
Iran	0.1	0.	0.1	0.	0.	0.
Azerbaijan	0.1	0.	0.1	0.	0.	0.
Turkmenistan	0.1	0.	0.1	0.	0.	0.

[a]difference to column 1 table 16

[b]difference to column 2 table 16

Table 18: Nabucco, Nucleolus, Decreased Demand

	without South Stream				*with South Stream*	
	Nucleolus [%]	Impact of pipeline sections[a] TC, ES	WS	TC, ES, CS, WS	Nucleolus [%]	Impact[b] TC, ES, CS, WS
Russia	1.5	−0.6	−0.4	−0.6	1.5	−0.6
Ukraine	8.	−0.2	−0.1	−0.2	8.	−0.1
Belarus	7.5	−0.1	0.	−0.1	7.5	−0.1
Norway	3.4	0.	0.	0.	3.4	0.
Netherlands	1.	0.	0.	0.	1.	0.
UK	1.6	0.	0.	0.	1.6	0.
Center	26.6	−0.3	0.	−0.3	26.6	−0.3
Center-East	13.7	−0.2	0.	−0.1	13.7	−0.2
Italy	5.	−0.1	0.	−0.1	5.	0.
Poland	2.8	0.	0.	0.	2.8	0.
France	10.5	−0.1	0.	−0.1	10.5	−0.1
Belgium	4.8	−0.1	0.	−0.1	4.8	−0.1
Balkan	1.6	0.3	0.3	0.3	1.6	0.3
Turkey	11.	0.8	0.2	0.8	11.	0.8
Iraq	0.1	0.1	0.	0.1	0.1	0.1
Iran	0.3	0.2	0.	0.2	0.3	0.2
Azerbaijan	0.3	0.3	0.	0.3	0.4	0.3
Turkmenistan	0.1	0.	0.	0.	0.1	0.

[a]difference to column 2 table 16

[b]difference to column 3 table 17

A.5 Fragmented Market with Exclusive Access

Fragmented Market: Shapley Value

Table 19: Nord Stream, Shapley Value, Fragmented Market

Players	Shapleyvalue [%]		
	without Nord Stream	with Nord Stream	difference
Russia	15.1	18.3	3.1
Ukraine	8.7	6.9	−1.8
Belarus	5.2	4.7	−0.5
Norway	10.5	8.	−2.6
Netherlands	5.4	4.3	−1.1
UK	2.	1.8	−0.2
Center	20.3	23.4	3.1
Center-East	8.2	7.8	−0.4
Italy	2.	2.3	0.3
Poland	2.2	1.8	−0.3
France	5.8	6.2	0.4
Belgium	4.4	4.4	0.
Balkan	0.9	0.9	0.
Turkey	7.2	7.2	0.
Iraq	0.	0.	0.
Iran	1.2	1.2	0.
Azerbaijan	0.7	0.6	0.
Turkmenistan	0.1	0.1	0.

Table 20: South Stream, Shapley Value, Fragmented Market

	without Nord Stream		*with Nord Stream*			
	Shapley value [%]	Impact[a] OS, NW, SW	Shapley value [%]	Impact of pipeline sections[b] OS	OS, NW	OS, NW, SW
Russia	16.6	1.5	19.3	0.3	0.8	1.1
Ukraine	6.7	−2.1	5.6	−0.3	−1.2	−1.3
Belarus	5.1	−0.2	4.6	0.	−0.1	−0.1
Norway	9.6	−0.9	7.6	0.	−0.3	−0.3
Netherlands	5.1	−0.3	4.2	0.	−0.1	−0.1
UK	2.	0.	1.8	0.	0.	0.
Center	20.1	−0.2	22.8	0.	−0.5	−0.6
Center-East	8.8	0.6	8.1	0.	0.6	0.3
Italy	2.4	0.4	2.5	0.	0.	0.2
Poland	2.	−0.1	1.8	0.	0.	0.
France	5.9	0.1	6.3	0.	0.	0.1
Belgium	4.4	0.	4.4	0.	0.	0.
Balkan	2.4	1.5	1.9	0.3	0.8	1.1
Turkey	7.2	0.	7.2	0.	0.	0.
Iraq	0.	0.	0.	0.	0.	0.
Iran	1.1	−0.1	1.1	−0.1	−0.1	−0.1
Azerbaijan	0.6	−0.1	0.6	−0.1	−0.1	−0.1
Turkmenistan	0.1	0.	0.1	0.	0.	0.

[a]difference to column 1 table 19

[b]difference to column 2 table 19

Table 21: Nabucco, Shapley Value, Fragmented Market

	without South Stream				*with South Stream*	
	Shapley value [%]	Impact of pipeline sections[a] TC, ES	WS	TC, ES, CS, WS	Shapley value [%]	Impact[b] TC, ES, CS, WS
Russia	15.3	−2.4	0.	−3.	16.1	−3.2
Ukraine	6.3	0.1	−0.2	−0.6	5.5	−0.1
Belarus	4.7	0.	0.	0.	4.6	0.
Norway	7.6	−0.1	0.	−0.4	7.3	−0.3
Netherlands	4.1	−0.1	0.	−0.2	4.	−0.2
UK	1.8	0.	0.	0.	1.8	0.
Center	22.9	−0.2	−0.1	−0.5	22.5	−0.3
Center-East	8.2	0.	0.1	0.4	8.4	0.3
Italy	2.2	0.	0.	0.	2.5	0.
Poland	1.8	0.	0.	0.	1.8	0.
France	6.3	0.	0.	0.	6.3	0.
Belgium	4.4	0.	0.	0.	4.4	0.
Balkan	1.8	0.4	0.1	0.9	2.6	0.7
Turkey	9.5	1.9	0.1	2.3	9.2	2.1
Iraq	0.5	0.5	0.	0.5	0.5	0.5
Iran	1.1	−0.2	0.	−0.1	1.1	−0.1
Azerbaijan	1.3	0.4	0.	0.6	1.2	0.6
Turkmenistan	0.2	0.	0.	0.1	0.2	0.1

[a]difference to column 2 table 19

[b]difference to column 3 table 20

Fragmented Market: Nucleolus

Table 22: Nord Stream, Nucleolus, Fragmented Market

Players	Nucleolus [%] without Nord Stream	Nucleolus [%] with Nord Stream	difference
Russia	4.9	4.3	−0.7
Ukraine	7.	6.8	−0.2
Belarus	7.6	7.8	0.2
Norway	1.7	1.	−0.6
Netherlands	0.3	0.3	0.
UK	1.8	1.8	0.
Center	28.2	28.3	0.1
Center-East	14.3	14.4	0.1
Italy	4.6	5.	0.4
Poland	2.7	2.9	0.2
France	10.5	11.1	0.6
Belgium	5.1	5.1	0.
Balkan	0.8	0.8	0.
Turkey	10.3	10.3	0.
Iraq	0.	0.	0.
Iran	0.	0.	0.
Azerbaijan	0.	0.	0.
Turkmenistan	0.	0.	0.

Table 23: South Stream, Nucleolus, Fragmented Market

	without Nord Stream		*with Nord Stream*			
	Nucleolus [%]	Impact[a] OS, NW, SW	Nucleolus [%]	Impact of pipeline sections[b] OS	OS, NW	OS, NW, SW
Russia	4.5	−0.4	4.4	0.	0.1	0.1
Ukraine	6.9	−0.2	6.8	0.	−0.1	0.
Belarus	7.7	0.1	7.8	0.	0.	0.
Norway	1.1	−0.5	1.	0.	0.	0.
Netherlands	0.3	0.	0.3	0.	0.	0.
UK	1.8	0.	1.8	0.	0.	0.
Center	28.3	0.	28.3	0.	0.	0.
Center-East	14.2	−0.1	14.2	0.	0.	−0.2
Italy	5.	0.3	5.	0.	0.	0.
Poland	2.9	0.2	2.9	0.	0.	0.
France	11.	0.5	11.1	0.	0.	0.
Belgium	5.1	0.	5.1	0.	0.	0.
Balkan	0.8	0.	0.9	0.	0.	0.
Turkey	10.3	0.	10.3	0.	0.	0.
Iraq	0.	0.	0.	0.	0.	0.
Iran	0.	0.	0.	0.	0.	0.
Azerbaijan	0.	0.	0.	0.	0.	0.
Turkmenistan	0.	0.	0.	0.	0.	0.

[a] difference to column 1 table 22

[b] difference to column 2 table 22

Table 24: Nabucco, Nucleolus, Fragmented Market

	without South Stream				*with South Stream*	
	Nucleolus [%]	Impact of pipeline sections[a] TC, ES	WS	TC, ES, CS, WS	Nucleolus [%]	Impact[b] TC, ES, CS, WS
Russia	1.7	−2.	−0.2	−2.6	1.9	−2.5
Ukraine	7.7	0.4	0.	0.8	7.6	0.8
Belarus	7.7	0.	0.	0.	7.7	0.
Norway	1.	0.	0.	0.	1.	0.
Netherlands	0.3	0.	0.	0.	0.3	0.
UK	1.8	0.	0.	0.	1.8	0.
Center	28.2	−0.1	0.	−0.1	28.2	−0.1
Center-East	14.5	0.	0.	0.2	14.4	0.2
Italy	5.	0.	0.	0.	5.	0.
Poland	2.9	0.	0.	0.	2.9	0.
France	11.1	0.	0.	0.	11.1	−0.1
Belgium	5.1	0.	0.	0.	5.1	0.
Balkan	1.7	0.8	0.2	0.8	1.7	0.8
Turkey	11.	0.8	0.	0.8	11.	0.8
Iraq	0.	0.	0.	0.	0.	0.
Iran	0.1	0.1	0.	0.1	0.1	0.1
Azerbaijan	0.1	0.1	0.	0.1	0.1	0.1
Turkmenistan	0.	0.	0.	0.	0.	0.

[a] difference to column 2 table 22

[b] difference to column 3 table 23