Gazdálkodástani
Doktori Iskola

TÉZISGYŰJTEMÉNY

Kaderják Péter

From oil-indexed to hub-based gas wholesale pricing in Hungary

című Ph.D. értekezéséhez

Témavezető:

Prof. DSc. Wetzker Konrád

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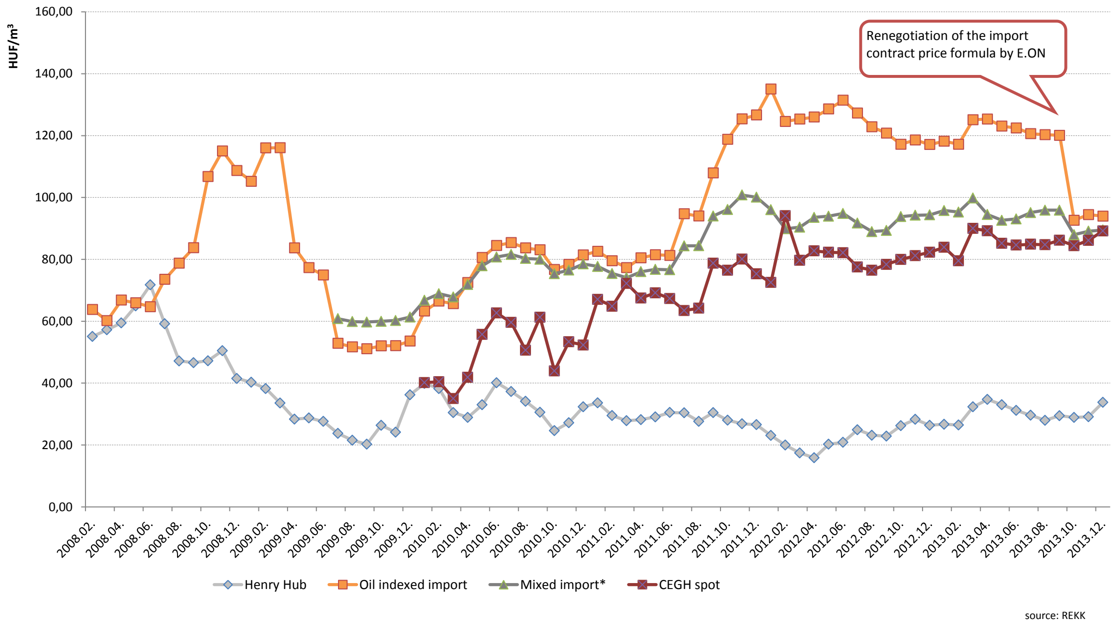
1 Research background and major research hypotheses

Despite the long standing traditions of its oil and gas industry, favourable geological conditions and location, as well as its developed natural gas infrastructure, the Hungarian natural gas market is still in a fragile situation. This is reflected by the fact that natural gas has become the synonym of Russian dependence, high heating bills for households and – as a consequence of the 2009 January gas crisis and the present Russia-Ukraine conflict – energy supply security risk in recent years.

The performance of the Hungarian gas wholesale market in the five years between the fall of 2008 (the beginning of the last economic recession) and 2013 reflects its inefficiency. On the North-West European core markets oversupply and increased competition resulted in wholesale natural gas prices 20-40% below the oil-indexed price, which has been the benchmark for Hungary[1] (see Figure 1). In those five years Hungarian customers could benefit from favourable West-European market trends only due to regulatory intervention.

Figure **1**. The development of oil-indexed, spot, and mixed natural gas prices, January 2008 – December 2013



Source: REKK analysis

[1] This margin remained even in the period of increasing spot gas prices after the Fukushima nuclear disaster on March 11, 2011 and the follow-up demand shock caused by increased Japanese demand for liquified natural gas (LNG). From October 2013 Gazprom finally adjusted its supply price much closer to market levels for its Hungarian partners (E.ON and then MVM).

The primary objective of this study is to identify the principal conditions for a transition from monopolistic (oil-indexed)[2] natural gas wholesale pricing to hub-based pricing in Hungary. It is also about simulating the wholesale price impacts of policy measures to remove the obstacles to efficient gas wholesale competition in the country.

The major hypothesis of the paper is that the major obstacles to efficient gas wholesale competition and related pricing to develop are the followings in Hungary:

(i) *Exclusive control over a pivotal infrastructure*, the (Russia-)Ukraine-Hungary interconnector (in the followings: UA-HU interconnector), that ensures a dominant market position for the Russian supplier.

(ii) The present major Russian long term contract (LTC), held by a single Hungarian wholesaler, as a principal source of *wholesale market concentration.*

(iii) *Regulatory constraints to market development*; this study will concentrate on identifying *potentially distortive access rules* to critical interconnectors.

Table 1 below summarises the assumed relationship between the combinations of obstacles (i) and (ii) above to gas wholesale market competition and gas wholesale pricing regimes.

Table 1. Assumed relationship between the combinations of obstacles to gas wholesale market competition and gas wholesale pricing regimes

		POSITION OF THE RUSSIAN SUPPLIER			
		Pivotal infrastructure		No pivotal infrastructure	
		With LTC	Without LTC	With LTC	Without LTC
MARKET CONCENTRATION	High market concentration level	Oil indexed	Monopolistic	Partially oil-indexed	Oligopolostic
	Low market concentration level	Partially oil-indexed	Dominant price leadership	Oligopolistic / Competitive	Competitive

1.1 The pivotal nature of the Russian supplier to meet natural gas demand in Hungary

While in the short term lost Russian shipments through the UA-HU interconnector can be replaced by storage withdrawal, stored working gas can't be considered as additional

[2] Oil-indexed natural gas pricing should not be considered monopolistic in general. Such a pricing regime serves as a wholesale price risk management tool on e.g. liquefied natural gas markets. However, since the development of liquid gas hubs in Europe since 2008, oil indexed natural gas pricing became the synonym of monopolistic product pricing in the Central Eastern European context. This is why I use these expressions as synonyms in this paper

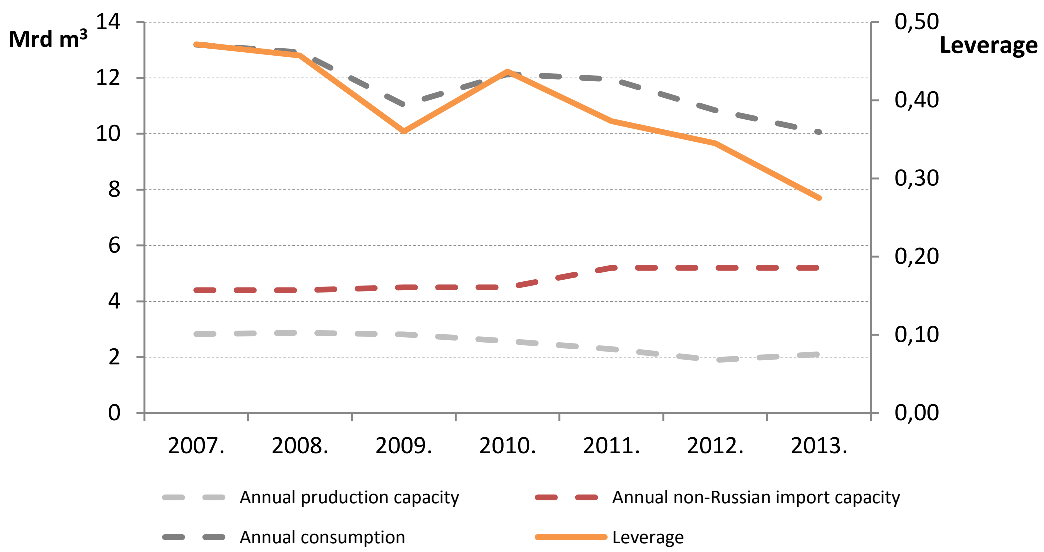
supply source on an annual or longer basis. Thus, when judging the pivotal nature of the UA-HU interconnector and related Russian supplies in meeting annual or longer term demand, I disregard from storage and, by following REKK (2011a), use the concept of *leverage* (L) in the following manner:

$$L = \frac{C - P - I_w}{C} \tag{1}$$

when C is annual gross natural gas consumption, P is for annual maximum domestic natural gas production capacity and I_w indicates aggregate gas import capacity from non-Russia-Ukraine directions. Positive values of this indicator mean that (unconstrained) annual consumption can't be met from domestic production plus potentially non-Russia controlled import directions.

Figure 2 indicate the development of the components of the leverage measure and its values for Hungary between 2007 and 2013.

Figure 2. The development of the components of the leverage (L) measure and its values for Hungary between 2007 and 2013



Source: own calculations based on FGSZ data

For the period 2011-2013 the values of the measure are 0.37, 0.35 and 0.27, respectively. This means that for these years 37%, 35% and 27% of annual natural gas consumption could only be covered from the UA-HU direction. By recalculating the formula in (1) when adding the planned SK-HU import capacity, we arrive at a value of –0.21 for 2013.

1.2 The leverage function

For policy making a more dynamic and fruitful application of formula (1) is to consider it as an energy policy objective function. I call it the *leverage function*, where the policy objective is to undermine, at minimum cost, the pivotal nature of a critical infrastructure that ensures a dominant market position for a supplier with exclusive rights to use the given infrastructure.

$$L(\psi, E, \tau, \sigma) = \frac{C(\psi(p,r,t),E) - P(p,\tau) - I_w(\sigma)}{C(\psi(p,r,t),E)} \quad (2)$$

The pivotal position is undermined when the value of L reaches a non-marginal negative value, say -0.2. At that point the supplier will know, with a fair level of certainty, that the infrastructure it controls is not any more pivotal in serving a given market. This poses a credible threat that monopolistic (e.g. oil-indexed) priced supply through the pivotal infrastructure[3] will face effective competition from gas shipped to the market from alternative directions.

The domain of the L function is [-∞; 1] and its value depends on both demand and supply side variables.

First, it depends on the demand for natural gas (C), which in turn depends on the price of gas for end-customers (ψ) and the level of *exogenous* energy efficiency investments (E)[4] that result in reduced natural gas consumption. End customer natural gas price is composed of the wholesale price of gas (p), regulated gas price components (e.g. system use charges, denoted by r) and taxes (t). The partial derivatives of C with regard to both ψ and E are negative.

[3] When monopolistic pricing arrangements (e.g. oil-indexed pricing) cancel due to e.g. the termination of long term contracts, this can be replaced by monopolistic pricing based on capacity withholding on the pivotal infrastructure.

[4] An increase in relative gas prices will encourage an increase in energy efficiency investments by increasing their profitability. These investments will decrease gas demand *ceteris paribus* and will be reflected in empirical gas demand functions. I will call these investments *endogenous* energy efficiency investments because they are related to changes in end customer gas prices. *Exogenous* energy efficiency investments, on the other hand, are energy efficiency investments largely independent from changes in relative gas prices. Typical examples are government subsidised building refurbishments programs.

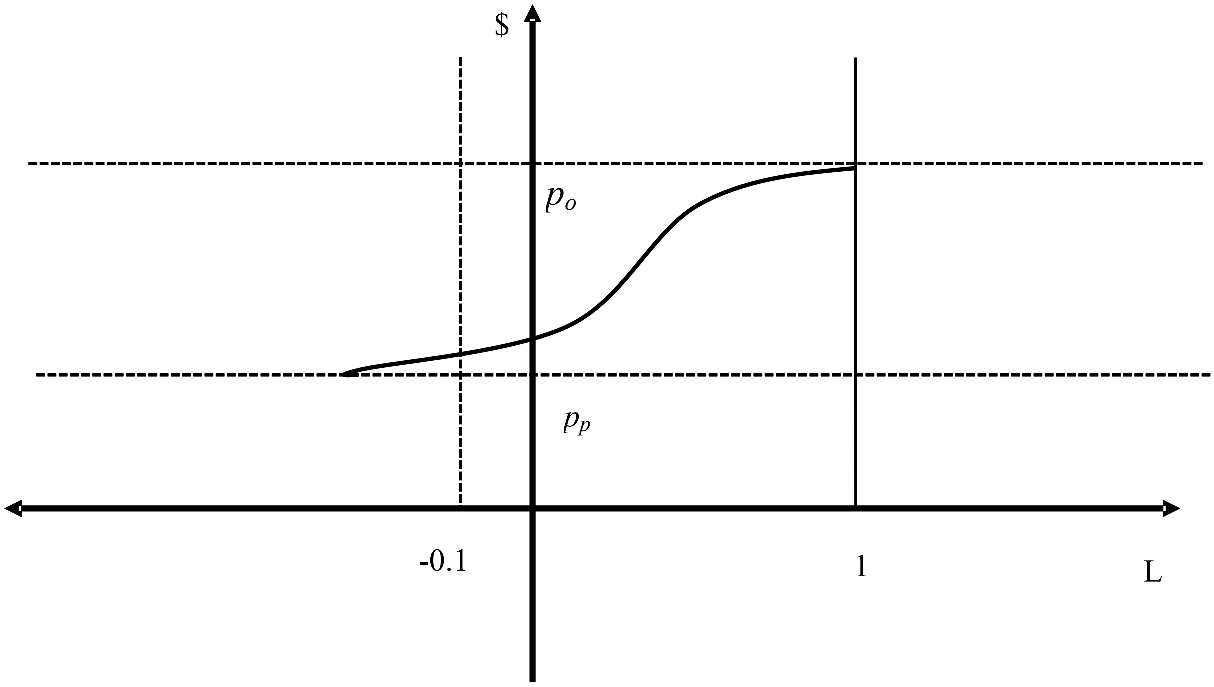
Second, the value of L depends on the level of domestic natural gas production. Within the constraints of principal gas reserves in a country, the level of production activity (P) will depend on the wholesale price of gas (p) in relation to production marginal cost and the level of government taxation on gas production (τ). The partial derivative of P with regard to p is non-negative, since increased gas prices will encourage increased exploration and production activities *ceteris paribus*, but the outcome of such activities is inherently uncertain. The partial derivative with regard to τ is negative.

Finally, an increase of gas import capacity from non-pivotal directions (I_w) will decrease the value of L. When gas transmission is a regulated business, which is the rule for the European Union, investments into additional natural gas transmission (including interconnectors) critically depend on the level of capital cost remuneration (e.g. weighted average cost of capital: WACC) provided through regulated transmission tariffs for the investors by the regulator (σ).

The leverage function clearly indicates those policy options and control variables that are available for a government[5] when it is to undermine dominant market positions based on the control of pivotal infrastructures. The *p(L)* function, denoted by Figure 3 illustrates the assumed relationship between p and L: the path stronger leverage can undermine monopolistic gas wholesale pricing (denoted by p_o: oil-indexed) and enforce market based gas prices (denoted by p_p: hub-based).

[5] For simplicity in the followings I mean government and regulatory measures together when I talk about „government measures", although important price regulatory decisions are in the authority of regulatory institutions largely independent from the government.

Figure 3. The assumed form of the wholesale price function, p(L)



We can see that the government has no direct influence on the *wholesale* gas price level: it is determined by demand and supply conditions, the latter having either a competitive (the case of p_p) or concentrated structure (the case of p_o). What the government has control over is to combine its powers over end-customer gas prices, energy efficiency subsidies, gas production related taxation and infrastructure investment related regulatory incentives so that their combined effect puts the pivotal supplier under competitive pressure. In order to make those variables under government control more explicit, we can reformulate (2) in the following way:

$$L(r,t,E,\tau,\sigma) = \frac{C(\psi(r,t),E) - P(\tau) - I_w(\sigma)}{C(\psi(r,t),E)} \quad (3)$$

1.3 Wholesale gas market characteristics and future scenarios

The primary structural problem of the Hungarian gas wholesale market is related to the LTC with Russia that has been providing the majority of supply sources to the market since 1996. The Hungarian counterparty to this contract has always had a dominant (over 50%) wholesale market share.

The subsequent market models that implemented the EU gas market liberalization rules under the Hungarian context have always been adjusted to acknowledge the existence of this LTC by first introducing the Public Utility market segment between 2004 and 2009 and then the Universal Service market segment. The LTC holder has always had a preferential supply right to serve these market segments.

The breakdown of oil indexed gas pricing started with increased short term trading through HAG[6]. The change in the dominant pricing regime might further accelerate from 2015 due to at least two major developments. First, the present LTC expire in 2015. Second, the new Slovakia-Hungary interconnector will become commercially operational and thus the pivotal nature of the Ukraine-Hungary interconnector will be gone. I assume these developments create a unique opportunity to shift the nature of gas wholesale competition from an oligopolistic towards a more efficient one in Hungary. This could also mean a shift from oil-indexed dominated towards spot gas pricing.

1.4 Distortive access rules to critical interconnectors

Cross border interconnection capacities with third party access are the single most serious threat to a dominant gas wholesaler under the market conditions prevailing in Hungary. Certainly, this threat translates to real competition only when competitively priced gas becomes available to be shipped to the market and access is allowed to cross border pipeline capacities.

By mid-2014 no regulated third party access is provided to the UA-HU interconnector in the Hungarian direction. The implementation of EU gas market rules in Ukraine due to obligations under its Energy Community membership might change this situation in the future. Access to HAG capacity is discriminative: while according to the Business Code of the gas system the rule for cross border gas transmission capacity allocation is auctioning in case of congestion, preferential access have been provided for two companies to the HAG capacity since 2011 by the government. Although the LTC holder has full access to the UA>HU interconnector without regulated third party access, capacity is also booked on HAG for the delivery of 20% of the LTC quantity. It

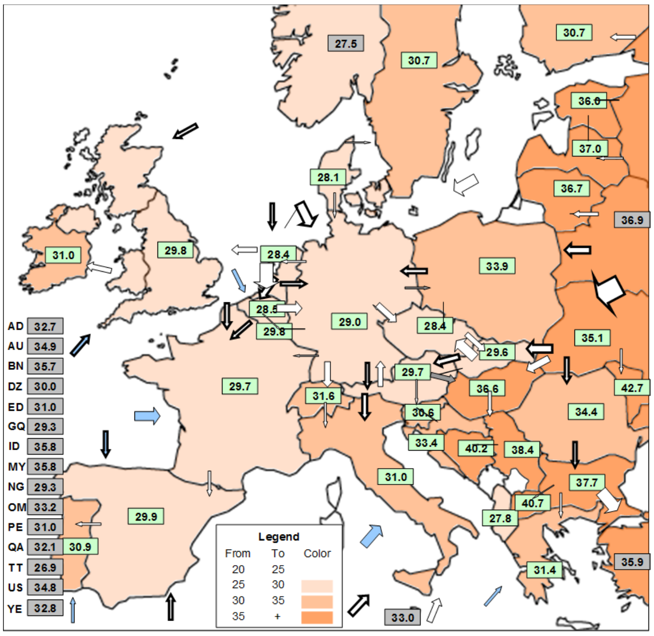
[6] The Austrian-Hungarian gas pipeline that was put in operation in 1996.

is critical for gas wholesale market development in Hungary, but still unclear, what capacity allocation rules will apply to the new SK-HU interconnector.

2 Modelling methodology: the EGMM[7]

For the upcoming simulations in section 7 I will use the European Gas Market Model that has been developed by my colleagues and myself to simulate the operation of an international wholesale natural gas market in whole Europe. Figure 4 shows the geographical scope of the model. Country codes denote the countries for which we have explicitly included the demand and supply side of the local market, as well as gas storages. Large external markets, such as Russia, Turkey, Libya, Algeria and LNG exporters are represented by exogenously assumed market prices, long-term supply contracts and physical connections to Europe.

Figure 4. Post-2015 gas wholesale market model scenarios by REKK (2013)



Given the input data, the model calculates a dynamic competitive market equilibrium for 35 European countries, and returns the market clearing prices, along with the production, consumption and trading quantities, storage utilization decisions and long-term contract deliveries.

[7] The following description was provided by the gas modelling team of REKK, composed of András Kiss (principal model author), Borbála Tóth (team leader), László Paizs, Adrienn Selei and Péter Kotek.

Model calculations refer to 12 consecutive months, with a default setting of April-to-March.[8] Dynamic connections between months are introduced by the operation of gas storages ("you can only withdraw what you have injected previously") and TOP constraints (minimum and maximum deliveries are calculated over the entire 12-month period, enabling contractual "make-up").

The European Gas Market Model consists of the following building blocks: (1) local demand; (2) local supply; (3) gas storages; (4) external markets and supply sources; (5) cross-border pipeline connections; (6) long-term take-or-pay (TOP) contracts; and (7) spot trading. The equilibrium state (the "result") of the model can be described by a simple no-arbitrage condition across space and time.[9]

Table 2. Summary of modelling input parameters and data sources

Category	Data Unit	Source
Consumption	Annual Quantity Monthly distribution (% of annual quantity)	Energy Community data, Eurostat, ENTSO-G
Production	Minimum and maximum production	Energy Community data, ENTSO-G
Pipeline infrastructures	Daily maximum flow	GIE, ENTSO-G, Energy Community data
Storage infrastructures	Injection, withdrawal, working gas capacity	GSE
LNG infrastructures	Capacity	GLE, GIIGNL
TOP contracts	Yearly minimum maximum quantity Seasonal minimum and maximum quantity	Gazprom, National Regulators Annual reports, Platts, Cedigaz

[8] The start of the modeling year can be set to any other month.
[9] There is one, rather subtle, type of arbitrage which is treated as an externality, and hence not eliminated in the model. We assume that whenever long-term TOP contracts are (fully or partially) linked to an internal market price (such as the spot price in the Netherlands), the actors influencing that spot price have no regard to the effect of their behavior on the pricing of the TOP contract. In particular, reference market prices are not distorted downwards in order to cut the cost of long-term gas supplies from outside countries.

3 Simulation scenarios and results

This section defines the simulation tasks and scenarios to test my hypotheses by the use of the EGMM. Controlled experiments are executed so that hypothetic scenarios or market/policy settings for Hungary are developed and their wholesale price outcomes are derived in a European market context that best represent actual supply, demand, infrastructure and contractual conditions. The scenarios are built around changes in few policy variables that are assumed to have the most significant wholesale price impact while the rest of the variables are controlled (unchanged). The Hungarian scenarios are not intended to be 'realistic' in terms of representing actual market conditions. Their aim is to represent stylised, sometimes extreme market settings in order to test the responsiveness of wholesale pricing outcomes to changes in some critical policy variables.

3.1 Simulating the partial impacts of marginal policy changes on Leverage and gas wholesale prices under contract and infrastructure constrained perfect competition

Section 3 identified available government measures to undermine pivotal infrastructure positions. Demand side measures include those affecting end-customer prices (like the tax wedge between retail and wholesale gas prices or regulated tariff components) and exogenous energy efficiency investments. An important supply side measure is to encourage domestic gas production by a favourable investment environment, e.g. by setting low relative extraction taxes (royalty). An additional government measure is to encourage investment into gas import capacity from non-pivotal directions, e.g. by providing sufficiently high regulated return for such investments. According to the hypothesis, once the pivotal infrastructure position is undermined, oligopolistic (oil-linked) gas prices will also be undermined. This hypothesis assumes a functional relationship between the measure to identify a pivotal infrastructure, namely the Leverage index as defined in (1) and gas wholesale prices, ceteris paribus (see Figure 3).

One way to test the above hypothesis would be to carry out the econometric estimation of the invers of the leverage function in (3):[10]

[10] Note that in (3) t and τ helps to delink end-customer prices and production levels from wholesale gas price fluctuations respectively, thus resolving the endogenity of p and L apparent in (2).

$$p(L) = p\,(r, t, E, \tau, \sigma). \tag{4}$$

However, the lack of sufficient data prohibited to follow this way.

Instead, this section provides estimates on the functional relationship between *p* and *L* based on EGMM simulation values.

The process of simulation is as follows. I start to run the model with a Hungarian reference case with a relatively high *L* value. In the reference case 2012 consumption and production data and 2014 infrastructure and tariff data is used for all countries endogenously modelled by EGMM. In the reference case the value of *L* is 0.35 for Hungary, Russian LTC is 100% oil-indexed priced and no spot Russian gas is available for the market.[11]

The hypothesis is that due to the high positive *L* value for the reference case, the modelled wholesale gas price for Hungary will be closer to the oil-linked price. Next I generate (*p;L*) value pairs or observations by introducing marginal changes in the determinants of the L function: gas demand, domestic gas production and aggregate gas import capacity from non-Russia-Ukraine directions. I derive the partial impact of marginal policy changes on *L* and *p* values as follows:

[1] From the reference case I start to reduce reference demand (110.75 TWh in 2012)[12] in marginal blocks (5 TWh) until the *L* value reaches -0.2, ceteris paribus and derive related wholesale price estimates.

[2] From the reference case (25.2 TWh annual maximum production capacity) I start to increase maximum capacity of domestic production in marginal blocks (5 TWh) until the *L* value reaches -0.2, ceteris paribus and derive related wholesale price estimates.

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[11] In light of recent Russian LTC renegotiations and the spreading practice of mixed spot-oil indexed LTC pricing the assumption of 100% oil indexed pricing by Russia might seem unrealistic. However, my objective here is to test the capacity of alternative policy measures to put pressure on oil indexed pricing. To develop a theory on Russian gas pricing under regulatory and competitive pressures is a topic for another study.

[12] During the calculations it is assumed that 1 Bcm = 9.77 TWh

[3] From the reference case I start to increase import capacity from non-Russia-Ukraine directions in marginal blocks (5 TWh/year) until the *L* value reaches -0.2, ceteris paribus and derive related wholesale price estimates. Two alternative sub-scenarios have been developed to test the impact of alternative development options.

[3A] In the first case only the HAG capacity was expanded by marginal blocks (5 TWh/year) until *L* reached a sufficiently low value (< -0.2).

[3B] In the second case the SK-HU interconnector was implemented first in marginal blocks (5 TWh/year) until it reached the actual planned capacity (127 GWh/day SK-HU capacity) and then HAG expanded until *L* reached a sufficiently low value (< -0.2). To reach *L*= -0.2 ceteris paribus next to the SK-HU capacity an extension of AT-HU capacity with 40 GWh/day was also necessary.

The EGMM derives yearly average wholesale price estimates under contract (LTC) and infrastructure (interconnection capacity) constrained perfect competition. Thus the results of the above simulations will be informative on the partial wholesale price impacts of different policy measures to improve leverage for Hungary under the specific assumptions about contract and infrastructure constrained perfect competition inherent for the EGMM model.

3.2 Simulation results

Figures 5-8 summarise the results of the first simulation round. The results illuminate the capacity of policies discussed in the context of the Leverage function in (2) to undermine Russian oil-indexed gas pricing when Russia is not willing to adjust its pricing policy to apparent competitive pressure. Modelled German prices plus transmission tariffs from Germany to Hungary are used as an approximation for hub-based pricing.

Figure 5. Modelled impact of marginal demand reductions on leverage and gas wholesale prices

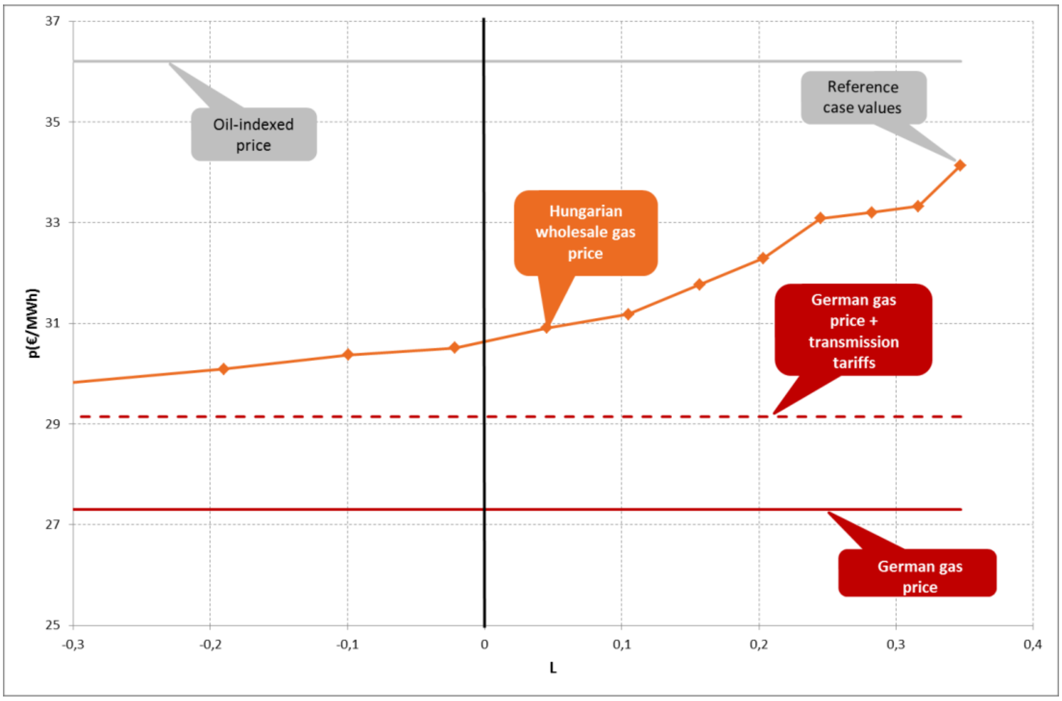


Figure 6. Modelled impact of marginal domestic production increases on leverage and gas wholesale prices

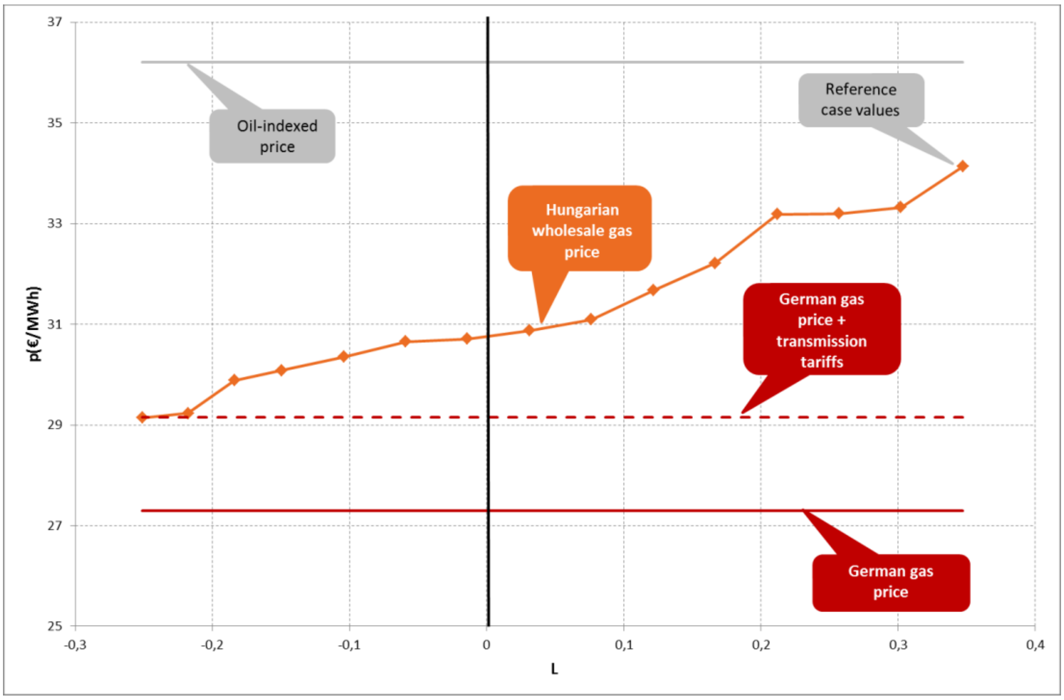


Figure 7. Modelled impact of marginal HAG capacity expansions on leverage and gas wholesale prices

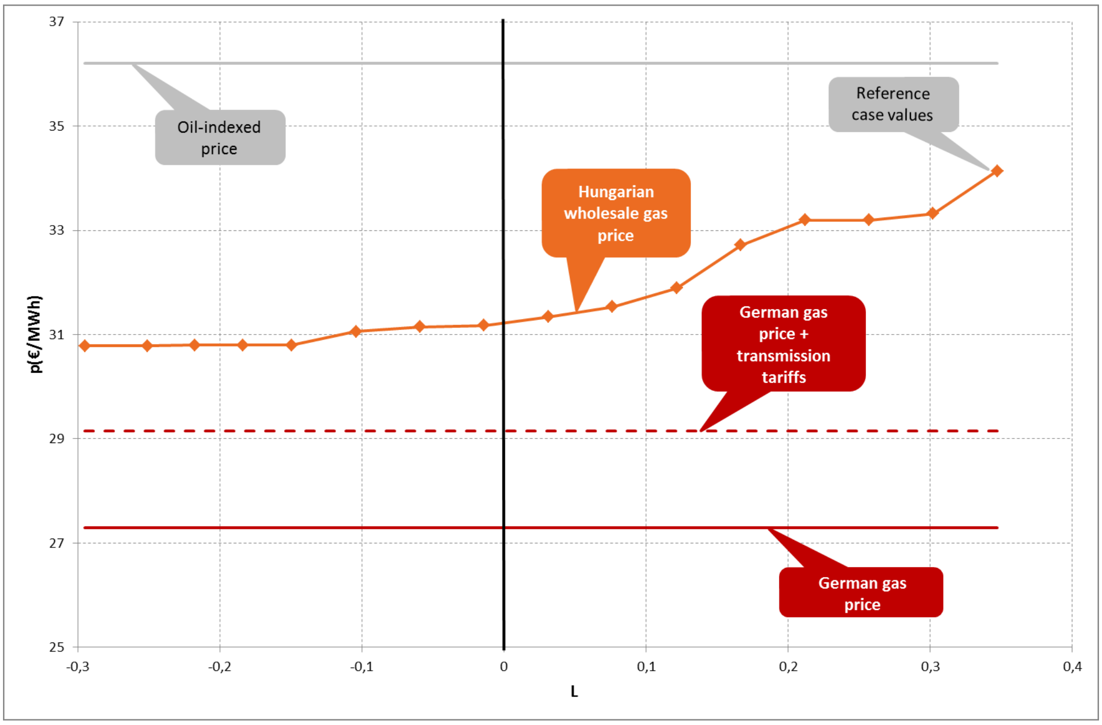
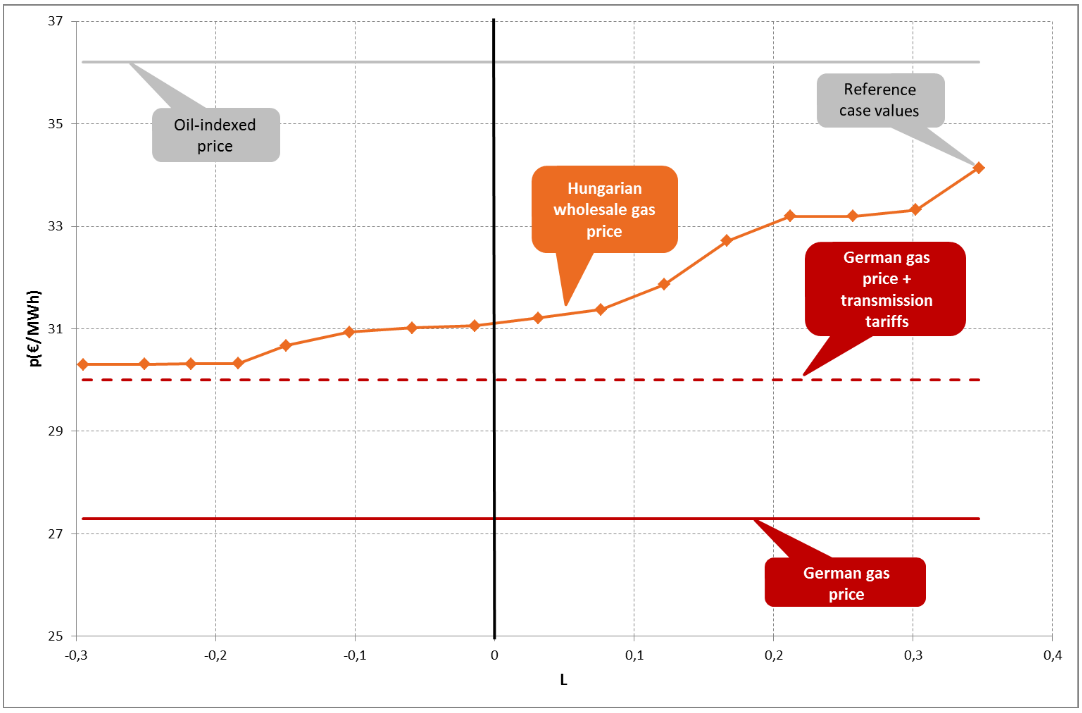


Figure 8. Modelled impact of marginal SK-HU and follow up HAG capacity expansions on leverage and gas wholesale prices



The following conclusions can be drawn from the above results.

- In the reference case the modelled Hungarian wholesale price (34.1 €/MWh) is only 6% below the oil-indexed price (36.2 €/MWh). The oil indexed price is 24%, the reference price is 17% over the hub-based price (29.2 €/MWh).
- The above simulation results reproduce the hypothetic functional form illustrated on Figure 3. All three policies by themselves (and most probably in combination) can lead to a gradual move from close-to oil-indexed to close-to hub-based gas wholesale pricing.
- At $L \approx 0$ values all partial policies result in 10% wholesale price decrease compared to the reference case.
- To encourage domestic production to increase and the implementation of the SK-HU interconnector seem to be the most efficient policies to arrive at hub-based wholesale prices at L values around -0.2.
- The least effective policy seems to be the expansion of only the HAG capacity due to congestion at the German Austrian interconnector.

An overall conclusion is that *under only contract and infrastructure constrained perfect competition*, policies that result in an L value ≈ -0.2 are sufficient to manage an almost full transition from oil-indexed to hub based gas wholesale pricing in Hungary. An exception is when only the HAG capacity is expanded. The partial impact of demand reduction policies seems to be a bit slower to produce close-to hub based gas wholesale prices.

3.3 Simulation of the impact of additional market and regulatory distortions on gas wholesale prices in Hungary

In the second round of simulations additional market and regulatory distortions are introduced and their impacts on gas wholesale price development investigated. The simulations are related to the testing of the hypothesis formulated in the Introduction about the major obstacles to moving from oil-indexed to spot gas wholesale pricing in Hungary. The existence of a pivotal infrastructure, gas wholesale market concentration and distortive cross border capacity access rules were assumed to be the most detrimental market characteristics for spot pricing to develop on the Hungarian market (see also Table 1 on the assumed relationship between the first two obstacles and likely gas wholesale pricing regimes).

For simulation purposes I define two possible, stylised states with regard to each of the three market/policy characteristics and thus create 8 possible market/policy scenarios for Hungary to compare. As in the case of previous simulations, the reference case includes 2012 consumption and production data and 2014 infrastructure and tariff data for all countries endogenously modelled by EGMM except for Hungary. For the Hungarian market I will control for demand, production and underground storage characteristics so that they will remain unchanged in all the subsequent simulations.

In the eight simulation scenarios the following alternative states will apply with regard to the investigated market/policy characteristics:

- *Pivotal infrastructure.* In the Hungarian context, the potential pivotal infrastructure is the UA>HU interconnector. I will represent the existence versus the lack of its pivotal position by two alternative infrastructure settings. The first will reflect interconnection conditions in the reference case with an L value of 0.35 (UA>HU is pivotal). In the alternative case L = -0.2 due to the implementation of the fully bi-directional SK>HU interconnector and further extension of HAG.

- *Market concentration.* The concentration of the Hungarian wholesale market is represented by two alternative LTC volumes. High concentration translates to a 8 Bcm (78.16 TWh)/year, 100% oil-indexed (36.2 €/MWh) LTC with ± 15% flexibility (see dominant wholesaler model in section 1.3). Low market concentration is represented by a 2 BCM (19.54 TWh)/year, 100% oil-indexed LTC with the same flexibility (see Universal Service + Competition scenario in the same section). Russian spot gas is not available in any of the two scenarios (having a very high price).

- *Distortive access to interconnectors.* With regard to capacity booking for LTC holders two alternatives are considered again. In the first type of scenario (see Scenarios 1, 2, 5 and 6 below) LTC gas can only be delivered to the Hungarian market through the UA>HU interconnector. This is the stylized case when the regulator prohibits capacity booking for LTC holders on interconnectors falling under regulated third party access rules. In the second type of scenario regulated third party access interconnectors are used first for delivering LTC gas and if needed for larger contracts, the remaining amount flows to the Hungarian market through the UA>HU interconnector. More precisely, in Scenario 7 70% of contracted quantity is delivered through HAG (up to full capacity) and for the delivery of the remaining 30% UA>HU capacity is used. In Scenario 8 100% LTC gas flows on HAG, in Scenario 3, 55% flows on SK-HU (up to its full capacity) and the remaining 45% on HAG. Finally, in scenario 4 100% LTC gas flows on the SK-HU interconnector. Only remaining capacity, if any, is available for spot trading on these interconnectors in case of second type Scenarios.

Table 3 summarises the major characteristics of the simulation scenarios.

Since Scenario 2 is the closest to a competitive market/policy setting (strong leverage, low market concentration, no cross border capacity blocking), I expect this scenario to result in a gas wholesale price closest to hub-based prices (approximated by modelled German wholesale prices). On the other end, being the least competitive setting, I expect Scenario 7 (low leverage, high market concentration, cross-border capacity blocking) to result in closest to oil-indexed prices.

Table 3. Alternative market/policy setting simulation scenarios

Assumptions		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8
Leverage	L = 0,35 (2011)					x	x	x	x
	L = - 0,2	x	x	x	x				
Market concentration	LTC: 8 Bcm	x		x		x		x	
	LTC: 2 Bcm		x		x		x		x
Capacity blocking	UA>HU: 100%	x	x			x	x		
	UA>HU: 0%, SK>HU (HAG)			x	x			x	x

3.4 Simulation results

Tables 4 summarises the results of the second simulation round by individual scenarios. Hungarian and German wholesale prices and profits from LTC gas sales are indicated.

Profit from LTC is the difference between the revenue of the LTC holder from selling the TOP (at least ACQ-flexibility) volume at equilibrium market price and the cost of purchasing it at 100% oil indexed prices.

Table 4. Wholesale prices and LTC profits in the different market/policy simulation Scenarios

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8
HU price (€/MWh)	30,7	30,2	31,8	31,6	30,8	31	34,9	35
DE price (€/MWh)	27,4	27,5	27,5	27,4	27,4	27,6	27,2	27,4
HU-DE Price spread (€/MWh)	3,3	2,7	4,3	4,2	3,4	3,4	7,7	7,6
Profit from long-term contract (m€)	-574	-152	-267	-29	-580	-139	-297	-89

The following conclusions can be drawn from the results.

- All the scenarios result in negative profits for LTC contract holders. This indicates that 100% oil indexed gas is already under heavy competition in the EU and also the Hungarian market.
- As expected, Scenario 2 provides for the wholesale price closest to hub based pricing at moderate LTC loss.
- Scenario 4 is a version of Scenario 2 with distortive access of LTC holders to the SK-HU interconnector. The results indicate that distortive access in case of a small LTC and abundant interconnection capacity falling under regulated third party access rules results in minimum LTC related negative profits at moderate price increase compared to Scenario 2. Thus this could be considered as a loss minimization scenario.
- Scenarios 5 and 7 indicate that large volume LTCs produce the highest negative profits for LTC holders. As for Scenario 5, the combination of low leverage, high LTC volume and full spot competition through HAG creates the largest LTC related financial loss.
- The lesson from Scenario 7 is that the gigantic financial loss of Scenario 5 can be reduced by distortive access to HAG at the cost of a very high wholesale price increase on the Hungarian market. Scenario 7 indeed provides for the worst combination of market/policy conditions and indeed results in close to oil-indexed wholesale prices.

- Scenario 8 is a version of Scenario 7 with reduced LTC contract volume. While this scenario also results in a close to oil-indexed wholesale price, the reduced contract volume significantly decreases LTC related financial losses under conditions of low leverage and full spot competition through HAG.

Next we can compare the performance of Scenarios along the major investigated policy dimensions in terms of the average wholesale price and the average LTC profit they result in.

First, there is a significant trade-off between wholesale price levels and the extent of distortive access to regulated third party access interconnectors. Distortive access moderates the financial loss of the LTC holder company at the cost of increasing wholesale prices. To the contrary, undistorted competition through regulated third party access interconnectors brings wholesale prices closest to hub-based levels at the cost of significant financial loss for the incumbent wholesaler.

Second, a small LTC seems to help minimizing LTC related losses while large LTC scenarios produce the highest financial losses for incumbents.

Finally, better leverage matters mostly pricewise. Scenarios with $L = -0.2$ value produced an average wholesale price being the second closest to the hub-based price.

4 Summary of results and directions for future research

This study identified the principal obstacles to a transition from monopolistic (oil-indexed) natural gas wholesale pricing to hub-based pricing in Hungary as (i) the exclusive control over a pivotal infrastructure (namely the UA-HU interconnector), (ii) high level market concentration and (iii) the foreclosure of the Hungarian gas wholesale market by blocking capacities of regulated third party access interconnectors.

It introduced the leverage function to help the consistent analysis of available government measures to undermine dominant market positions based on the control of pivotal infrastructures. It also assumed a functional relationship between leverage and the prevailing gas wholesale price so that under contract and infrastructure constrained perfect competition a sufficiently low leverage value (<-0.2) would bring about close to hub-based gas wholesale prices. However, when high level market concentration and additional regulatory distortions in the form of distortive interconnection access spoil perfect competition, the relationship between leverage and the prevailing wholesale gas price becomes unclear.

In order to assess the efficiency of available supply side, production and infrastructure development related policy measures to undermine a dominant market position and to encourage a transition from oil-linked to hub-based gas pricing in Hungary, controlled experiments or simulations were carried out with a contract and infrastructure constrained perfect competition gas market model, the European Gas Market Model. Additional simulations tested the wholesale price impacts of 8 stylised market/policy settings for Hungary defined along the dimensions of leverage, wholesale market concentration and access rules to critical interconnectors.

The simulation results provided strong support for the research hypotheses. They could reproduce the hypothetic functional form between leverage and related gas wholesale price outcomes. It was found that under contract and infrastructure constrained perfect competition those policies resulting in a leverage value around -0.2 are sufficient to manage an almost full transition from oil-indexed to hub based gas wholesale pricing in Hungary. To encourage domestic production and the implementation of the SK-HU interconnector seem to be the most effective policies to arrive at hub-based wholesale prices.

Once the possibility of high level market concentration (in the form of a large volume LTC) and distortive access to non-Russian-Ukrainian interconnectors is introduced, the market/policy setting with strong leverage, low market concentration and no cross border capacity blocking results in a gas wholesale price closest to hub-based prices. The higher market concentration (i.e. the volume of a LTC) becomes, the higher the financial risk the LTC holding dominant gas wholesaler is facing. Simulations also found a significant trade-off between wholesale price levels and the extent of distortive access to regulated third party access interconnectors. Distortive access moderates the financial loss of the LTC holder company at the cost of increasing wholesale prices. To the contrary, undistorted competition through regulated third party access interconnectors brings wholesale prices closest to hub-based levels at the cost of significant financial loss for the incumbent wholesaler.

5 References

ACER/CEER (2013), *Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2012*. November 2013. www.acer.europa.eu. doi: 10.2851/14037

Ascari, S., (2013), *The Gas Target Model for the Visegrad 4 Region. Conceptual Analysis*. May 2013, Warsaw. www.osw.waw.pl.

Boltz, W. (2009a), *Regulatory reactions to the 2009 January gas crisis and the coming winter.* In: Security of gas and electricity supply in Central and South-East Europe, Summary of the presentations of the first workshop, p. 14. www.rekk.eu/sos.

Boltz, W. (2009b), *Management of the gas supply disruption in Austria, January 2009 – experience and lessons learned.* Presentation prepared at E-Control, January 21, pp 20-22.

Cameron, P., Tóth, A. I, Kaderják, P., Mezősi, A. és Szolnoki, P. (2008). *Disruption and security of supply*. In: Kaderják és Labelle (szerk), *Impact of the 2004 Enlargement on the EU Energy Sector.* Budapesti Corvinus Egyetem, REKK, Budapest.

Chevalier, Jean-Marie (2006), *Security of Energy Supply for the European Union*, European Review of Energy Markets, Volume 1: Issue 3 – November.

EC (2011), European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. *A Roadmap for moving to a competitive low carbon economy in 2050*. COM (2011) 112/4 Provisional text.

EC (2014), European Commission, Communication from the Commission to the European Parliament and the Council. European Energy Security Strategy. COM (2014) 330 final

Energy Community (2013), *Development and Application of a Methodology to Identify Projects of Energy Community Interest*. DNV KEMA, REKK, EIHP. November 2013. http://www.energy-community.org.

Henderson, J. and Heather, P., (2012), *Lessons from the February 2012 European gas „crisis"*, Oxford Energy Comment, Oxford Institute for Energy Studies, April.

Kaderják, P. ed. (2011), *Security of energy supply in Central and South-East Europe.* Budapesti Corvinus Egyetem, REKK, Budapest.

Kovacevic, A. (2009), *The Impact of the Russia–Ukraine Gas Crisis in South Eastern Europe.* Oxford Institute for Energy Studies, March 2009, NG 29.

Laffont, J-J., (2005). *Regulation and Development*. Cambridge University Press.

Noel, P. (2008). *Beyond dependence: how to deal with Russian gas*. European Council on Foreign Relations (ecfr.eu).

Pirani, S., Stern, J. and Yafimava, K. (2009), *The Russo-Ukrainan gas dispute of January 2009: a comprehensive assessment.* Oxford Institute for Energy Studies, February 2009, NG27.

Stern, J. P. and Rogers, H., (2012), *The Transition to Hub-Based Pricing in Continental Europe*. in: Stern, J. P. ed. (2012), *The Pricing of Internationally Traded Gas*. The Oxford Institute for Energy Studies, Oxford.

Stern, J. P. ed. (2012), *The Pricing of Internationally Traded Gas*. The Oxford Institute for Energy Studies, Oxford.

6 Related former publications of the author

Journal articles in Hungarian:

- Mezősi A. – Szabó L. – Kaderják P. (2011): Hőpiaci energiafelhasználás és szén-dioxid-kibocsátás becslése 2030-ig, *Magyar Energetika*, 2011/6, pp. 24-27.

- Kaderják P. – Cameron, P. - Tóth A. I. (2008): Egyoldalú földgázimport-függőség: egy új energiaellátás biztonsági kérdés Európa számára. *Pro Minoritate*, Volume **17**, ősz-tél, pp. 1-25.

- Kaderják P. (2005): Egy ígéret nyomában (nem lesz gázáremelés), *Polgári Szemle*, 1/10. szám.

- Kaderják P. – Ábrahám Á. – Pál G. (2005): A csökkenő halálozási kockázat közgazdasági értéke Magyarországon, *Közgazdasági Szemle*, LII, március, pp. 231-248.

Book chapters in Hungarian:

- Kaderják P. - Kiss A. - Paizs L. - Selei A. - Szolnoki P. - Tóth B. (2012): 'Infrastrukturális fejlesztések szerepe a gázpiaci integrációban – elemzések a Duna-régió gázpiaci modellel', in: *Verseny és szabályozás*, pp. 256-282. MTA KRTK Közgazdaság-tudományi Intézet.

- Kaderják P. (2009): 'Energiapolitika – a 2008. év fejleményei', in: *Magyarország politikai évkönyve 2008-ról*, Demokrácia Kutatások Magyar Központja Alapítvány, 994-1015.

- Kaderják P. (2009): 'Energiapolitika', in: *A jóléti rendszerváltás csődje*. Századvég Kiadó, Budapest, 271-295.

Working papers in Hungarian:

- Kaderják P. - Mezősi A. - Paizs L. - Szolnoki P. (2010): Energiapolitikai ajánlások 2010 - A hazai árampiaci szabályozás kritikája és javaslatok a továbblépésre. Regionális Energiagazdasági Kutatóközpont, Budapesti Corvinus Egyetem, Műhelytanulmány, 2010. február.

Journal articles in English:

- Meeus, L. - Azevedo, I. - Kaderják, P. - Kotek, P. - Pató, Zs. - Szabó, L. and Glachant, J-M (2013): Regulating Building Refurbishment in the Context of the Energy Roadmap 2050. *European Energy Journal* **3** (2013), Issue 3, 34-39.

- Kaderják P. – Cameron, P. – Tóth A. I. (2007): Unilateral Natural Gas Import Dependence: a New Supply Security Risk for Europe*, European Review of Energy Markets* **2**, 57-92.

Book chapters in English:

- Kaderják P. (2011): 'The Lessons of the January 2009 Gas Crisis in Central and Eastern Europe', in: Vinois, J.A. (ed), *The Security of Energy Supply in the European Union*, pp. 193-219. Claeys and Casteels.

- Kaderják P. (ed) (2011): Security of Energy Supply in Central and South-East Europe. Budapesti Corvinus Egyetem, REKK, Budapest. pp. 198-218.

- Kaderják P. (2006): 'Preconditions of Electricity Market Integration in Seven Central and Southern Eastern European Countries', in: LaBelle, M. and Kaderják, P. (ed), *Towards More Integration of Central and Eastern European Energy Markets*, Budapesti Corvinus Egyetem, REKK, Budapest, 45-87.

- Kaderják, P. – Antall Gy. (2005): Country chapter on 'Hungary', in: Cameron, Peter D. (ed), *Legal Aspects of EU Energy Regulation - Implementing the New Directives on Electricity and Gas Across Europe*, Oxford University Press, 375-403.

Working papers in English:

- Kaderják, P. - Paizs, L. - Selei A. and Tóth B. (2014): Impact of US LNG exports on Central and Eastern Europe's Energy Security. Issue paper prepared for the Atlantic Council Conference "*American Energy Prowess in a Strategic Foreign Policy Perspective*", Atlantic Council, Washington, D.C., April 2014. www.atlanticcouncil.org.

- 'A Comparison of Electricity Market Models of CEE New Member States'. Working Paper, European Regulation Forum on Electricity Reforms. http://www.sessa.eu.com/documents/wp/D33_1_Kaderjak_final.pdf