Assoc. Professor Yuli Radev, PhD

NATURAL GAS TRADING IN EUROPE IN TERMS OF MARKET DISEQUILIBRIUM

The paper deducts the models of the static and dynamic disequilibrium on the base of more careful presentation of the classical concepts of market equilibrium, looking for the common origin, and the process of negotiation. The theory of disequilibrium is integrated with empirical researches of the gas sector in Europe, resulting in generalized comments.

JEL: B13; C23; H21; L24; L95

According to the theory of disequilibrium, the market equilibrium is an abstract gravitation center, toward which the trade exchange is directed, or is adjusted, through the process of negotiation between contractors. The final result of this process is a sequence of temporarily balancing spot markets and long-term contracts, binding the agents for more then one trade phase. Such a vision for the trade interrelations gives an opportunity to establish a generalized theoretic framework, which combines the theories of market equilibrium – theory of intertemporal equilibrium, theory of temporary equilibrium and theory of rational expectations with the theories of long-term contracts – theory of agencies, theory of transaction cost and the theory of property rights.[1]

Market models and disequilibrium

It is noteworthy that many of the features of disequilibrium are deducted back in time under conditions of sharp scientific debates at the beginning over the status of static, and later over the dynamic equilibrium of markets.

Contradictory views of Edgeworth (1881) and Walras (1874) and their followers for causality between market equilibrium and bilateral contracting contribute to the promotion of the demand and supply model of Marshall (1890). Assuming that the negotiations are the key component of the process of adjustment of the market toward its equilibrium, Marshall gave the answer of question why the Walras' equilibrium is the most acceptable compromise of the indeterminacy of Edgeworth. In this particular analytical framework the concept of disequilibrium appears, presenting the bilateral negotiations as a reason, not as consequence of equilibrium, and the state of equilibrium as imaginary final condition. The major shortcoming of the model of Marshall is that it depicts the partial and the overall economic equilibrium under specific conditions without any perspective in to the future. The choice of isolated length of time means that economic phenomena are not exhibited and that the economic fundamentals remain constant.

The problem is that in the course of time larger or smaller, but irreversible changes have always been made. The careful analysis of the most popular, production

[1] The author is highly influenced and impressed by Michel de Vroy and Franco Donzelli.

model of Walaras, shows that implicitly it contains intertemporal characteristics. The subsequent studies and especially the model of forming of capital and crediting of Walras proved this inference. Moreover Morgenstern (1935), Hayek (1937), Hicks (1939), Lindahl (1939) etc. used the last model of Walras to incorporate the time in the standard stationary notions of the equilibrium. The main conclusion from the scientific debates during the 1930-s is that the dynamic development of the markets depends on the formation of the expectations and preliminary design of the trade agreements.

From the point view of disequilibrium the most significant result from these debates is the *Theory of Temporary Equilibrium* of Hicks (1939), revived in last two decades of 20^{-th} century with the additions made by Grandmont (1977). On the analogy of the model of static equilibrium of Marshall, the theory of Hicks assumed two equilibrium concepts, as the *temporary equilibrium* is reached immediately, and the disequilibrium is the process of adjustment to the *stable dynamic equilibrium*. However, in contrast with the static equilibrium the stable dynamic equilibrium is not a gravity point, but a gravity or referential track or simply orbit, around which the true trajectory converges. The identical approach to both types of mechanisms is an opportunity to deduct a generalizing theoretical framework of disequilibrium for static and dynamic perspectives in the market development.

The idea for dynamic development of markets got a true recognition with the emergence of the theory of complete markets of K. Arrow (1953) and G. Debreu (1959). The theory Arrow-Debreu, which, from one side, accepts the future economics, described by Hicks (1939), and from another, is a step back to the concept of perfect foresight, in fact illustrates the ideal equilibrium track. The whole trade with large but finite traders, time intervals and goods is completed (thanks to the perfect foresight) before the start of the analyzed (limited) time horizon. The traders sign perfect (comprehensive) contracts, with which they overcome the uncertainty, generated by the economic fundaments, and guarantee performance of all transactions on the specified future dates. The dynamic or intertemporal (the term used to be for this theory) equilibrium, which is established before the start of economic activity, is a single concept and a single criterion for equilibrium, adjustment and balancing of the markets. The disequilibrium doesn't appear under any forms, that is why neither corrections, nor additional negotiations are necessary. The last finding means, that the Arrow-Debreu equilibrium is a dynamic analogue of static equilibrium in the production model of Walras.[2]

Due to its unrealistic assumptions, the theory Arrow-Debreu lost popularity during the 1970^{-ies} mainly on the account of the theory of rational expectations, but also of the reviving theory of temporary equilibrium. Although the traditional neoclassical school identified the theory of rational expectations with the analysis of intertemporal substitutions in the model of real business cycle and shows it as the most modern analytical framework of the equilibrium, in similar way as the theory of temporary

[2] Until 1954, when William Jaffe translated all the volumes of *The Elements of Pure Economics* (1871), Leon Walras is associated only with his production model, promoted by Cassel (1918).

equilibrium of Hicks, this theory can also be presented in terms of disequilibrium. An argument in favor of this proposition is the fact, that in his analysis Lucas (1972) abandoned the dominated interpretations (as in the Keynesian model) of real business fluctuations from the position of market failure and the assumption of "learning from errors", and as Hayek tried to do before, incorporated the business cycle into the "territory of the theories of the value". Furthermore, of the three conditions for the existence of dynamic equilibrium – market balancing, perfect foresight and single criterion of equilibrium, the theory of rational expectations recognizes only the first one. In contrast to the theory of temporary equilibrium, however, which admits only one equilibrium track, around which all possible trajectories gravitate, each trajectory in the theory of rational expectations is an equilibrium track.

We accept that the theory of rational expectations also agrees with the dynamic adjustments of the markets, but it doesn't investigate this process through the lens of equilibrium/disequilibrium. The different interpretation is a matter of form, not of contents. The fact that the dynamic adjustment is not called disequilibrium, doesn't mean that it doesn't exist. The differentiation made by Grossman (1977, 1981) and Radner (1979) of fully revealing (Pareto dominant) equilibrium and partially revealing information (Pareto dominated) equilibrium at rational expectations confirms this thesis.

From the point of view of the mechanism of the dynamic disequilibrium the following important generalization could be made. Apart from (assuming that it doesn't appear) the extrinsic or behavioral uncertainty (due to the behavior of economic agents), the economy of Arrow-Debreu insures all the intrinsic uncertainty (due to the economic fundamentals), and the intertemporal equilibrium illustrates the overall gravity track, around which the trajectories from the theory of temporary equilibrium converge as well as these from the theory of rational expectations.

Long-term contracting and disequilibrium

The interpretation of the concepts for contract and contracting changed in the sequential structure of the markets in terms of disequilibrium. The contract became synonyms of long-term contracts, which are trade agreements, signed in one trade phase and performed in the next trade phase(s). The interest in the long-term contracts is also provoked by the necessity to insure extrinsic (behavioral) uncertainty. With this alternative, the trade relations are implemented either on sequential spot markets or through long-term contracts, and the organization structure of industries is a balance between the two forms of trade.

The role of long-term contracts as an instrument for dynamic adjustment of individual plans and expectations under conditions of extrinsic uncertainty is most clearly stated in the context of information asymmetry between traders in the agencies models. In such cases the *complete* long term contracts signed ensure efficient coordination of trade relations, providing that all uncertainties are taken in to account in the most rational way (Grossman, Hart, 1980).

The impossibility to construct entirely detailed contracts sheds light on the incomplete contracting and the concept of bounded rationality (Simon, 1962), which during the 1970-s was still a marginal and unknown part of economic science (De Alesi, 1983). The assumption of bounded rationality suggests that it is impossible all the uncertain situations to be identified in advance, therefore the long-term contracts remain incomplete. Incomplete contracts are also consistent with the hypothesis for rational behavior, expressed in correct foresight or the second best decision of the agents. However, since the 1970^{-s} the concept of incomplete contracting is an alternative of this hypothesis, neo-classics prefer complete contracts, and more recently their application for solving the problems with information asymmetry.

During the second half of 1980^{-s} there was a new wave of theoretical and empirical investigations of incomplete contracts. This scientific literature, which most remarkable part is the theory of property rights, is constructed around the concept of transaction cost. As Williamson (1996) states, the incomplete contracting is a fully formalized version of theory of transaction cost. The main difference between both theories is the fact that the theory of property rights considers the incomplete contract from the point of view of neoclassical postulate of full rationality. However, it is a cause for tension between the analysts of incomplete contracts and the followers of neoclassical economics. The attempts to solve this growing controversy resulted in the formation of two alternative economic streams. The first one, which is defended and implemented by the representatives of the agency theory (Tirole, 1994), rejects the theory of incomplete contracts, admitting that the complete (and optimal) contracts is the only appropriate framework for interpretation of contract relations. Conversely, the second stream relies only on bounded rationality and incomplete contracting. As usual, the truth is probably somewhere in the middle, and the both streams in contracting, adding the theory of rational expectations (with complete contracting) and the theory of temporary equilibrium (with incomplete contracting), form two alternative models of dynamic disequilibrium.

Several tasks could be formulated out of the presented brief historical overview of microeconomics. Their solving will depict the main aspects of the new theoretical approach, the *theory of disequilibrium*: (1) Definition of mechanisms of static and dynamic disequilibrium; (2) Analysis of the theory of intertemporal equilibrium Arrow-Debreu in its role as a dynamic equilibrium track; (3) Systematization (and combination) of alternative theoretical models of sequential markets and long term contracts; (4) Analysis of incomplete contracting and assumption of bounded rationality in the behavior with the intention to expand the descriptive capabilities of the theory of disequilibrium; (5) Presentation of the organizational structures of industrial sectors as a balance between spot markets and long term contracts; (6) Analysis of spot markets and long term contracts, considering the interrelations between both trade forms.

The solution of the last two tasks can be presented through the international trade of natural gas, where spot markets and long-term contracts coexist in parallel.

Three hypotheses about development of the gas sector in Europe are deducted and tested within the empirical research made by the author.

Empirical researches of natural gas trade in Europe

Without referring to any research, but knowing the nature of petroleum industry, characterized with limited competition,[3] with the approaching depletion of oil and gas and without any clear alternative for the future,[4] with the negative impact on the environment and with the necessity from sustainable development (without being biased towards circulated models), we declare the thesis, that the long-term contracts will remain the most efficient way of hedging the risks. The kind of contracts, their duration, protective clauses, idiosyncratic relationships, and other details, will be determined by the existing and situated spot markets and by the factors of efficient contracting in different sectors.

The main hypothesis for organizational structure of gas sector in the countries from European Union (EU) is that the balance between spot markets and long-term contracts in this sector depends on ratio between long-term and short-term price elasticities. This hypothesis is a result of theoretical analysis of consumer demand, which shows under what conditions the long-term contracts are necessary for the insurance of extrinsic risk, and under what conditions the contracts are profitable both for the consumers and producers. The fact, that the structure of this sector is very specific was taken into account in the performed and used analyses of gas sector. Natural gas has been traded traditionally with long-term contracts, and the spot markets appeared as a consequence of political decision and deregulation. This aspect to some extent contradicts to the theoretical concepts, in which the leading reason for signing of binding traders long-term contracts is the competition between producers on the spot markets.

For Allaz and Vila (1993) at constant price elasticity of demand and trade made on several contract stages in competitive framework of Cournot, the oligopoly producers supply part of their production through pre-emptive transactions with long-term contracts. Producers gradually lost their interest to keep the supply on the spot markets, and prices fell. This tendency is projected in the negotiation of long-term contracts, and the prices in natural gas trade go down as a whole. Consumers gain from long-term contracts, as in any subsequent stage producers sell more volumes at lower price. If producers enter into a secret agreement, and none of them sign the contract, all they will gain. But the individual producer gains, when he enters in long-term agreements, getting ahead of competitors.

However, with increasing price elasticity all the producers can gain from the opportunity to sign long-term contracts. “Promising” lower prices, long-term contracts

[3] We recall the cliché, that where there are pipes and wires, there is not real competition.

[4] In the present growth of extraction, the operation life of oil will continue for another 35 years and of natural gas for 70 years.

stimulate consumers to invest in specific for the particular energy consumption equipment. That expands the scale of the markets of natural gas, and further increases the gain of the producers in the long run. The size of this effect depends on the ratio between (high) price elasticity in long term and (low) price elasticities in the short term.

Neuhoff and Hirshhausen (2006) compare the gains with and without long-term contracts, as in their analysis the main determinants are the number of producers and ratio long-term/short-term elasticity (the relative elasticity). Even with its simplicity and very strong assumptions accepted, this analysis leads to fundamental conclusions. For small values of relative elasticity (γ) the market dominates over long-term contracts and the producers gain from the pure spot trade. When γ exceeds 4.8, the benefits from long-term contracts, stimulating the growth of the market, constantly increase and oligopoly producers gain from the contracting. For the consumers the long-term contracts are beneficial, regardless of the values of γ, because the prices of the trade with contracts are lower than the prices on pure spot trade.

The empirical results to high degree confirm the above conclusion. In their studies of natural gas consumption Al-Sahlawi (1989) and Estrada and Fugleberg (1989), for example, find that in the industry sector long-term elasticity exceeds the short-term elasticity 4-5 times, whereas for the public sector and households the relative ratio is between 5 and 10. Comparing empirical researches, we can admit that the critical relative elasticity (over which the long-term contracts are beneficial) is 3-4 for the industry sector, and 4-5 for the households. The higher is the relative elasticity, the higher is the benefit and respectively the power of long-term contracts.

Valuable conclusions and predictions for the organizational structure of the gas sector in Europe can also be made from the experience of the USA in the liberalization of gas sector. Under conditions of deregulation in this sector four stages can be outlined, characterized with: excess of long term contracts; liberalization; increasing prices; deficit of long term contracts. The perspective is, after brief lull, even changed, the role of long-term contracts to increase.

The estimates of long-term and short-term elasticities of demand of gas against the price and other variables, involved in the energy demand functions, could be received through the specific models and methods. The starting point in modeling of energy demand is the dynamic lag log-linear regression model of Koyck (1954). This model most closely approximates to the real choice, allows for easy processing of data, and which is most important, it calculates directly the both kinds of price elasticity of demand (see Enclosure 1).

The TSCS (Time Series–Cross Section) data generally combine the series of several cross sections. In the econometric model of demand of natural gas in Europe 12 countries were analyzed, and each of them was observed in the course of 9 - 20 years (see more in Radev, 2012). As at the combined TSCS data Ordinary Least Squares (OLS) method violates the basic assumptions about the statistical error, the estimates of elasticities are performed with several alternative methods. Besides OLS, in the research are used three other categories of methods: improved methods for

estimation of least squares; methods with heterogeneous coefficients of intercept; methods with heterogeneous slope coefficients.

The most well-grounded theoretically Method of Random Coefficients (RCM) represents the third category. According to this method, the uniform parameters in the cross sections of data are random variables, derived from overall probability distribution at constant hyper parameters. On the base of RCM the shrinkage estimators of Maddala (Maddala at al., 1997) were developed, which included the empirical approach of Bayes and the specific ex post probability distribution. The results from empirical researches confirm that, in comparison with all other methods, the shrinkage estimators give the most truthful predictions.

For calculation of the confidence intervals of the estimates, it was also suggested the using of different methods. The main problem is the fact, that short-term and long-term elasticities are linear and respectively non-linear functions of normally distributed parameters. Although in the previous researches the Delta method with the "naïve" confidential intervals is most commonly used, the bootstrap method definitely shows more reliable results.

The second hypothesis for organization of the gas sector in Europe is that the contracting process does not always follow the market. Contradictory effects of contracting and respectively of market trade are analyzed in terms of distribution of tax burden. When gas taxes change, the producers and consumers can avoid the tax burden at the expense of other parts of operational chain. In the international trade with natural gas, of particular interest is the option of shifting the tax burden to the foreign producers.

Traditionally the analysis of tax policy is performed with the market models, as the distribution of tax burden depends on the elasticity of demand and supply. This approach is a good starting point for more detailed interpretations of tax policy, because, as stated by Kotlikoff and Summers (1987), it reflects the basic principles in taxation, including the possibility for avoiding of taxes by the traders with more elastic demand and supply. The main shortcoming of market model (based on the model of partial equilibrium of Marshall) is the isolation from the other markets, although in the case of natural gas this theoretical vacuum can be filled with cross-elasticities against the prices of fuel oil and electricity.

In the dominated by the long-term contracts gas sector, however, the spot markets are important factor for distribution of tax burden, but mainly with the hidden impact on the ex post power to negotiate. Long-term contracts doesn't contain any special clauses for distribution of tax burden or the benefits from the changes in gas taxes, that is why the renegotiations play a key role in distribution of tax burden in the trade with natural gas.

From the model of negotiation of Nash three alternative opportunities for distribution of the tax burden could be derived, but they couldn't be tested empirically. Therefore, for examination of the second hypothesis a regression model was constructed, which estimated the impact of energy taxes (and other factors) over the import price of natural gas (see Enclosure 2).

The results from the investigation confirm that there is no reliable negative relation between the import price of natural gas and taxes, and contrary to the expectations created by the market model, the import countries can't shift the increasing tax burden to the producers. This also means that the hidden power of the spot market has no significant impact on the renegotiation of long term take-or-pay contracts in the gas sector in Europe (see more in Economic Studies, Book 2, 2013, p. 109-130).

The third hypothesis for the disequilibrium in the gas sector of EU is that during the process of the liberalization the duration of long term contracts decreases. There are two approaches for construction the models of contract duration. The first one is based on the empirical observations and investigations, which have to confirm or reject the hypothesis for economizing of transaction costs. Transaction costs themselves are estimated using the normative comparative analyses (Crocker and Masten, 1985, Hubbard and Weiner 1986). The second approach highlights the main determinants of transaction costs (specificity of the assets, uncertainty, and frequency of transactions) and quantifiable indicators, presenting these determinants. Regression analysis tested the impact of each of these proxy variables on the duration (or other component) of the contract.

In the studies of long-term contracts in the gas sector of Europe the second approach is updated. The empirical tests from the program "Globalization of markets of natural gas" made by Neumann and Hirschhausen (2004, 2006), Neuhoff and Hirshhausen (2005) at all, witnesses the thesis, that during the transition from monopoly to competitive market structure the interest in long-term contracts in the gas sector temporary decreased (see Enclosure 3). But in the long-term perspective the more flexible and with increasing duration long-term take-or-pay contracts will remain an irreplaceable instrument for raising the efficiency of the investments, security of supply and the competitiveness in the gas sector and energy industry as a whole.

Generalizations

In conclusion we will point out that our aim is to present the theory of disequilibrium as a logically arranged structure, consisting of all the key models of evolutionary development of microeconomic science. The most serious advantage of elucidating this theory is the combination of various models of static and dynamic equilibrium with the models of complete and incomplete contracting in alternative models of market disequilibrium.

As to empirical research the number of significant empirical studies of international contracts for supplying natural gas to the European Union countries is very limited, mainly because of lack of data. Unlike the U.S., where access to the signed agreements and relevant information on the details, terms, and corrective components of contracts after 1981 is free, in Europe there is hardly a more commercial secret than the conditions for the supply of natural gas. Therefore, the most frequently needed data is collected from public sources, and some of them are checked by experts.

Enclosure 1

Empirical analysis of demand of natural gas by households[5]

The empirical research covers the main European consumers of natural gas, as well as some countries from Central and Eastern Europe (CEE), using the southern part of the gas route Russia-Europe. A total 12 countries were analyzed, numbered as follows: Austria (1); Finland (2); France (3); Germany (4); Greece (5) Spain (6); Italy (7); the United Kingdom (8); Poland (9); Romania (10); Czech Republic (11); Bulgaria (12). The results from the research give an opportunity for deducting important conclusions and generalizations about new Europe and for comparative analysis of the years of transition in CEE.

Table 1.1

Statistical data for Bulgaria

Year	Demand of natural gas (toe/thous.cap)	Price of natural gas (EUR/toe)	Price of fuel oil (EUR/toe)	Price of electricity (EUR/toe)	Income (thous. EUR/cap)	HDD index
1995	0.60	119.98	228.03	0.00	0.98	2570
1996	1.22	124.17	210.99	0.00	0.78	2808
1997	1.84	158.24	284.54	786.36	0.92	2494
1998	2.47	149.14	317.40	754.07	1.05	2561
1999	2.73	115.39	305.06	740.56	1.20	2508
2000	2.82	138.75	332.86	621.25	1.28	2430
2001	3.04	156.95	292.49	585.88	1.46	2501
2002	3.25	152.78	361.03	608.50	1.62	2512
2003	3.20	171.16	472.69	711.89	1.70	2868
2004	3.48	177.04	672.86	762.94	1.86	2500
2005	3.63	186.34	829.42	767.09	2.05	2649
2006	3.91	227.30	902.06	837.69	2.32	2622
2007	4.42	257.85	1044.14	967.93	2.59	2356
2008	5.00	357.71	1366.19	1179.57	2.93	2430

The different variables are bounded into the dynamic log-linear model:

$$(1)\quad y_{t,i} = \beta_{0,i} + \beta_{y,i} y_{t-1,i} + \beta_{G,i} p_{G,t,i} + \beta_{E,i} p_{E,t,i} + \beta_{F,i} p_{F,t,i} + \beta_{m,i} m_{t,i} + \beta_{z,i} z_{t,i} + \varepsilon_{t,i},$$

for each $t=1,2,\ldots T_i$ (the number of the years, specific for each country) and $i=1,2\ldots12$ (the number of the countries), where:

[5] Radev, 2012.

$y_{G,t,i}$ = ln(residential natural gas consumption per capita in year t);

$y_{t-1,i}$ = ln(residential natural gas consumption per capita in year t-1);

$p_{G,t,i}$ = ln(residential real price of natural gas);

$p_{E,t,i}$ = ln(residential real price of electricity);

$p_{F,t,i}$ = ln(residential real price of fuel oil);

$m_{t,i}$ = ln(real income per capita);

$z_{t,i}$ = ln(real heating degree index);

$\varepsilon_{t,i} \sim N(0, \psi_i^2)$ is error term ($\psi_i^2 > 0$).

The subjective approach in the preferences and unadjusted interpretations of the parameters estimates and confident intervals are avoided by using eleven alternative estimators.

The first six are homogenous estimators: (1) Ordinary Least Square (OLS); (2) Generalized Least Square with the first order autoregressive error term (GLS-AR1); (3) Random Effects (RE); (4) Random effects with the first order autoregressive error term (RE-AR1); (5) Fixed Effects (FE); (6) Fixed Effects with the first order autoregressive error term (FE-AR1). In addition five heterogeneous methods are used: (7) Random Coefficient Models (RCM), which presented a common estimate for the whole database, determined by the two-step procedure of Swamy (1970); (8) Individual OLS on each country; (9) Individual GLS-AR1 on each country; (10) Iterative shrinkage estimators using country specific OLS estimates as initial values (Shrinkage, OLS); and (11) Iterative shrinkage estimators using country specific GLS-AR1 estimates as initial values (Shrinkage, GLS-AR1).

However, the attention is focused to the intermediate in respect to heterogeneity estimators of fixed effects (FE) and to the more innovative iterative shrinkage estimators of Maddala.

The processing of TSCS data is performed by the software product *STATA 8.1 Intercooled,* and the compatible product *GLLAMM* and *WinBUGS,* necessary for computing of shrinkage estimates.

As a whole the short-term elasticities are very low, tend to zero and are with low level of significance. In some countries heterogeneous estimates of these elasticities are with positive values, which unfortunately are projected in the long-run. Inclusion of a lag price of natural gas in the model doesn't change this fact. Although all the estimators provide wide ranges of the values of cross price elasticities, the positive signs, however, are indicators, that electricity and especially the fuel oil are substitutes of the natural gas.

As in other investigation of shrinkage elasticities (Maddala at al., 1997; Nilsen at al., 2005), this study provides positive price elasticities and negative elasticities in respect to income in long-term perspective, and price elasticities close to zero in the short-term perspective.

Table 1.2

Estimation of parameters of regression model*

Estimator		β_Y	β_G	β_F	β_E	β_m	β_z	β_o
OLS		0.967 (184)$^{1\%}$	0.030 (1.14)	-0.052 (-2.51)$^{5\%}$	-0.040 (-1.26)	0.015 (0.95)	-0.130 (-4.42)$^{1\%}$	1.618 (5.33)$^{1\%}$
GLS-AR1		0.967 (180)$^{1\%}$	0.033 (1.22)	-0.052 (-2.50)$^{5\%}$	-0.041 (-1.30)	0.014 (0.87)	-0.126 (-4.21)$^{1\%}$	1.588 (5.15)$^{1\%}$
RE		0.966 (163)$^{1\%}$	0.027 (0.95)	-0.050 (-2.28)$^{5\%}$	-0.034 (-1.03)	0.014 (0.85)	-0.128 (-3.85)$^{1\%}$	1.567 (4.78)$^{1\%}$
RE-AR1		0.963 (125)$^{1\%}$	0.061 (1.67)$^{10\%}$	-0.051 (-1.81)$^{10\%}$	-0.066 (-1.53)	0.006 (0.29)	-0.085 (-2.02)$^{5\%}$	1.292 (3.02)$^{1\%}$
FE		0.939 (37)$^{1\%}$	0.005 (0.11)	-0.006 (-0.15)	-0.036 (-0.79)	-0.001 (-0.00)	0.297 (1.86)$^{10\%}$	-1.790 (-1.44)
FE-AR1		0.813 (22.14)$^{1\%}$	-0.049 (-0.81)	0.019 (0.40)	-0.061 (-1.06)	0.139 (1.79)$^{10\%}$	0.162 (3.42)$^{1\%}$	-0.130 (-0.90)
RCM		0.461 (4.68)$^{1\%}$	-0.042 (-0.41)	-0.017 (-0.19)	-0.069 (-0.60)	0.998 (1.34)	0.582 (2.93)$^{1\%}$	-3.842 (-1.29)
OLS (ind.)	Min	-0.274	-0.628	-0.439	-0.661	-0.295	-0.347	-30.993
	Avg	0.320	-0.083	0.007	-0.055	1.308	0.672	-4.624
	Max	0.679	0.268	0.756	0.378	9.007	1.434	3.278
GLS (ind.)	Min	-0.250	-1.061	-0.426	-0.658	-0.304	-0.303	-31.272
	Avg	0.358	-0.142	0.006	-0.053	1.312	0.723	-4.679
	Max	0.677	0.273	0.756	0.315	8.801	1.778	2.238
Shrinkage OLS	Min	0.519	-0.191	-0.251	-0.373	-0.169	-0.042	-0.667
	Avg	0.662	-0.026	-0.020	-0.076	0.266	0.253	-0.211
	Max	0.784	0.151	0.081	0.083	0.828	0.563	0.023
Shrinkage GLS-AR1	Min	0.373	-0.219	-0.326	-0.437	-0.215	-1.403	-1.089
	Avg	0.608	-0.043	0.025	-0.055	0.400	0.374	-0.326
	Max	0.744	0.200	0.194	0.160	1.018	1.349	0.16

* The corresponding t-statistics at level of significance 1%, 5%, 10% are presented in brackets.

Enclosure 2

Empirical analysis of the import price of natural gas in Europe[6]

The exogenous determinants of the import price of natural gas are the oil price, gas taxes, and consumption per capita. The participation of the spot price of oil is due to the fact that the price formula of natural gas in the long term contracts depends mostly on this variable. This proposes a strong positive relation between import price of

[6] Radev, 2013.

gas and the oil price. The private consumption takes place in the model, because it most commonly causes removing of demand curve. The lag price of the natural gas is added, to reflex the cost of adjustment on the market. The contractual model for tax burden distribution is presented by the following regression:

(2) $p_{G,i,t} = \beta_i + \beta_{G,i} p_{G,t\text{-}1,i} + \beta_{o,i} p_{o,t,i} + \beta_{T,i} T_{t,i} + \beta_{m,i} m_{t,i} + \varepsilon_{t,i}$, where:

$p_{G,i,t}$ = ln(the import price of natural gas in country i in year t);

$p_{G,t\text{-}1,i}$ = ln(the lag import price of natural gas in country i in year t);

$p_{o,t,i}$ = ln(spot price of Brent oil);

$T_{t,i}$ = ln(tax levied on households);

$m_{t,i}$ = ln(income per capita).

In the model TSCS data was used for the 12 European countries in the period 2001-2008.

Table 2

Estimation of parameters of regression model*

Estimator	$\beta_{G,i}$	$\beta_{o,i}$	$\beta_{T,i}$	$\beta_{m,i}$	β_i
OLS	0.156 (4.10)$^{1\%}$	0.717 (19.74)$^{1\%}$	0.106 (5.14)$^{1\%}$	-0.05 (-2.75)$^{1\%}$	-0.001 (-0.01)
RE	0.139 (3.95)$^{1\%}$	0.723 (20.87)$^{1\%}$	0.105 (4.35)$^{1\%}$	-0.05 (-2.22)	0.06 (0.28)
FE	0.113 (3.43)$^{1\%}$	0.745 (14.45)$^{1\%}$	0.077 (0.89)	-0.019 (-0.14)	0.127 (0.56)

* For N = 84 observations, with adjusted R2 = 0.89. In the brackets are provided corresponding t-statistics with significance level of 1%, 5% and 10%.

The most important result from this analysis is the lack of reliable negative relation between the import price of natural gas and the taxes. This means that the hidden power of spot markets can't be transformed in contractual one (the second hypothesis).

The poor influence of the underlying market forces on renegotiation is likely due to the lack of effective spot gas markets in continental Europe. Transmission companies prefer long-term contracts to import natural gas from Russia, the Netherlands, Norway and Algeria. Most of these contracts (all with Netherlands and Norway) contain a flexibility clause allowing additional supplies. Even when the take-or-pay contracts are periodically renegotiated, they don't resemble to spot transactions. This is because, first, largely contracted volumes are fixed and not subject to renegotiation, and secondly, these contracts (almost) lacwant special tax provisions. At

this stage discord between contractual forces and those of spot markets can be considered as an objective need stimulating irreversible investments in infrastructure under conditions of political risk and increasing dependence on the natural gas.

Enclosure 3

Empirical analysis of duration of long-term take-or-pay contracts for supplying of natural gas in Europe[7]

Table 3

Estimation of parameters of regression model (Neumann, Hirshhausen, 2006)*

	2SLS			ML		
C	1305.588[1%] 163.365	10185.96[1%] 1235.146	630.286[1%] 87.111	1316.035[1%] 188.186	10267.06[1%] 1408.673	616.364[1%] 104.678
D	-0.646[1%] 0.082	-1338.297[1%] 162.576	-82.590[1%] 11.468	-0.652[1%] 0.095	-1348.954[1%] 185.40	-80.755[1%] 13.771
V	0.904[1%] 0.169	2.830[1%] 0.493	0,176[1%] 0.035	0.925[1%] 0.217	2916[1%] 0.565	0.174[1%] 0.040
P	6.799[1%] 1.195	6.282[1%] 1.167	0.373[1%] 0.065	6.981[1%] 1.424	6.528[1%] 1.393	0.382[1%] 0.122
R_{Arica}	-1,769 1.380	-1.806 1.364	-0.157 0.116	-2.099 1.733	-2.914 1.709	-0.177* 0.099
R_{Arica}	-1.734 1.202	-1.641 1.167	-0.138 0.085	-2.04 1.556	-2.000 1.516	-0.157* 0.102
Corr.R^2	0.460	0.508	0.415	0.450	0.481	0.405
Lag-Log				-421.194	-417.713	-69.525

*The estimated coefficients are presented at level of significance 1%, 5%, 10%. Below them are the corresponding standard deviations.

The duration of contracts (C) is regressed against the data of their signing (D), yearly contracting volumes (V), green projects, presented with dummy variable (P), and political risk (R).

The estimates are received with the two stage LS method (2SLS) and the maximum likelihood method (ML).

Bibliography:

Al-Sahlawi, M. (1989). The Demand for Natural Gas: A Study of Price and Income Elasticities. - The Energy Journal, 10, p. 77–87.

Allaz, B., J. L Vila (1993). Cournot Competition, Forward Markets and Efficiency. - Journal of Economic Theory, Vol. 59, p. 1-16.

[7] Radev, 2011, p. 216.

Arrow, K. (1964). The Role of Securities in the Optimal Allocation of Risk-Bearing. - Review of Economic Studies, Vol. 31, p. 91-96.

Cournot, A. (1838). Recherches sur les principes mathématiques de la théorie des richesses (Researches into the Mathematical Principles of the Theory of Wealth/1987 Engl. trans. by N.T. Bacon).

Crocker, K., S. Masten (1985). Efficient Adaptation in Long-Term Contracts: Take-or-Pay Provisions for Natural Gas. - American Economic Review, Vol.75, N 5, p. 1093-1093.

De Alessi, L. (1983). Property Rights, Transaction Costs, and X-Efficiency: An Essay in Economic Theory. - The American Economic Review, Vol. 73, N 1, p. 64-81.

Debreu, G. (1959). Theory of Value. New York: Wiley.

Diamond, P. (1967). The Role of a Stock Market in a General Equilibrium Model with Technological Uncertainty. - American Economic Review, Vol. 57, p. 759-776.

Edgeworth, F. Y. (1967). Mathematical Psychics: An Essay on the Application of Mathematics to the Moral Sciences. London: Kegan and Paul & Co. (1881 reprinted A. M. Kelly, New York).

Edgeworth, F. (1925). Papers Relating to Political Economy, 3 vols. London: Macmillan for the Royal Economic Society.

Estrada, J., O. Fugleberg (1989). Price elasticities of natural gas demand in France and west Germany. - The Energy Journal 10(3), p. 77–90.

Grandmont, J. M. (1977). Temporary General Equilibrium Theory. - Econometrica 45 (3), p. 535-572,.

Grandmont, J. M. (1987). Temporary Equilibrium: Selected Readings. New York: Academic Press.

Green, J. R. (1973). Temporary General Equilibrium in a Sequential Trading Model with Spot and Future Transactions. - Econometrica, Vol. 41, p. 1103-1123.

Grossman, S., O. Hart (1980). Takeover Bids, the Free-Rider Problem, and the Theory of the Corporation. - Bell Journal of Economics, Vol. 11, p. 42-64.

Hayek, F. (1937). Economics and Knowledge. - Reprinted in Hayek, F. (ed.) (1948). Individualism and Economic Order. Chicago: University of Chicago Press, p. 33-56.

Hayek, F. (1968). Competition as a Discovery Procedure. – In: Hayek, F. (ed.) (1978). New Studies in Philosophy, Politics, Economics and the History of Ideas. Chicago: University of Chicago Press, p. 179-190.

Hicks, J. (1946). Value and Capital, 1939, 2nd edition. Oxford: Clarendon Press.

Hubbard, G., R. Weiner (1986). Regulation and Long Term Contracting in US Natural Gas Markets. - Journal of Industrial Economics, Vol. 25, N 1, p. 71-79.

Koyck, L. (1954). Distributed Lags and Investment Analysis. Amsterdam: North-Holland.

Kotlikoff, L., L. Summers (1987). Tax incidence. – In: Auerbach, A., M. Feldstein. Handbook of Public Economics. Elsevier Science Publishers B.V, p. 1043-1092.

Leibenstein, H. (1966). Allocative Efficiency vs. 'X-Efficiency'. - The American Economic Review, Vol. 56, p. 392-415.

Lindahl, E. ([1939]1970). Studies in the Theory of Money and Capital. New York: Augustus M. Kelley.

Lucas, R. (1972). Expectations and the Neutrality of Money. - Journal of Economic Theory, Vol. 4, p. 103-124,.

Maddala, G., H. Li, V. Srivastava (1994). A Comparative Study of Different Shrinkage Estimators for Panel Data Models. - Annals of Economics and Finance, 2, p. 1-30.

Madlener, R. (1996). Econometric Analysis of Residential Energy Demand: A Survey. - Journal of Energy Literature, 2, p. 3–32.

Marshall, A. ([1890]1920). Principles of Economics, 8th edition. London: Macmillan,.

Morgenstern, O. (1935). Perfect Foresight and Economic Equilibrium, www.econ-pol.unisi.itp.

Neuhoff, K., C. von Hirshhausen (2006). Long Term Contracts for Gas Imports – A Theoretical Perspective. Cambridge: CMI Working Paper.

Neumann, A., C. von Hirschhausen (2004). Less Gas to Europe? An Empirical Assessment of Long-term Contracts for European Energy Supply. - Zeitschrift für Energiewirtschaft, Vol. 28, N 3, p. 175-182.

Radev Y. (2013). Distribution of Tax Burden in the Gas Sector in Europe. Economic Studies, N 2, c. 109-130 (*in Bulgarian*).

Radev Y. (2012). Empirical Analysis of Demand of Natural Gas by Households in Europe. - Economic Studies, N 4, p. 154-183.

Radev Y. (2011). Theory of Disequilibrium – Prospects to Gas Sector in Europe. St Ivan Rilsky Publishing House (*in Bulgarian*).

Radner, R. (1979). Rational Expectations Equilibrium: Generic Existence and the Information Revealed by Price. - Econometrica, Vol. 47:3, p. 655-678.

Simon, H. (1962). New Developments in the Theory of the Firm. - The American Economic Review, Papers and Proceedings, Vol. 52, p. 1-15.

Tirole, J. (1994). Incomplete Contracts: Where do We Stand? Walras-Bowley lecture, delivered at the North American Summer Meetings of the Econometric Society. Quebec City, Mimeo, IDEI, 53 p.

Walras, L. ([1874]1954). Elements of Pure Economics (translated by W. Jaffe). London: Allen and Unwin.

Williamson, O. (1996). The Mechanisms of Governance. Oxford: Oxford University Press.

4.II.2014