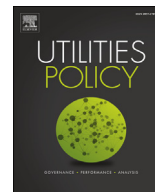




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The efficacy of liberalization and privatization in introducing competition into European natural gas markets

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ABSTRACT

This research examines the impact of EU liberalization policy tools on the rate of supplier switching in order to assess whether the objective of increased competition in the natural gas sector has been achieved. Three dynamic models are applied to a panel of 22 EU members between 1998 and 2013 to test the efficacy of eleven policy tools including privatization, in bringing competition to the market. Panel econometrics suggests that the liberalization tools implemented positively influence competition, although jointly rather than on a stand-alone basis. The implementation of pro-market regulations is associated with more competition in the sector. Among the various instruments, the virtual trading point, market-based balancing, market opening, and privatization have the greatest competition-enhancing potential.

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1. Introduction

The liberalization of natural gas markets in the European Union member states was officially initiated by the first gas directive of 1998 (Directive 98/30/EC). Since then, gas market restructuring has evolved and intensified, with two more gas directives (Directive, 2003/55/EC and Directive, 2009/73/EC) and two additional gas regulations (Regulation (EC) No 1775/2005 and Regulation (EC) No 715/2009) contributing to the process. The primary objective of the reforms was to introduce competition into the previously regulated gas industries, along with establishing an internal pan-European gas market.

As the gas sector still exhibits features of a network industry, namely large and specific sunk investments, substantial economies of scale, and massively consumed products (Spiller, 2011), there remains the possibility of traditional market and regulatory failures and the need for regulation or reregulation (Genoud and Varone, 2002; Jaag and Trinkner, 2011). The EU regulatory policy tools were intended precisely to establish the rules of competition in the sector and restrict the potentially uncompetitive behavior of incumbent companies. Following the example of the United States and the United Kingdom, the European Commission pursued the ‘competition over the network’ model of liberalization, which required carving out (unbundling) the natural monopoly services

related to infrastructure from the industry value chain (Klein, 1996). The gas industry was divided into potentially competitive segments (such as trade at the wholesale and retail levels) and natural monopolies requiring additional regulatory oversight due to impaired competition potential (transmission, distribution, storage). Although initially inspired by the deregulation in the Anglo-Saxon countries, the European Union eventually charted its own path to gas market liberalization.

The goal of this paper is to assess whether and which of the liberalization policy tools implemented in the EU member states, proved to be efficacious in opening up the potentially competitive segments of the natural gas industry. While previous studies analyzing the relationship of regulatory policy tools and performance mainly focused on gas prices (Brau et al., 2010; Copenhagen Economics, 2005; Florio, 2013; García, 2006; Growitsch and Stronzik, 2014), others investigated gas reforms effects on companies' financial and profitability indicators (Capece et al., 2013, 2012, 2010, 2009) or margins (García, 2006), comparable research on competition measures is lacking. Additionally, the limitation of earlier works is that the analyzed time span of the reforms' effects did not extend beyond the year 2007.

The inclusion of the post-2007 period is important, however, for at least three reasons. Firstly, the last European gas directive, which imposed new regulatory solutions and enhanced the previous ones, came into effect in 2009. Secondly, the biggest single enlargement of the European Union took place in May 2004 and involved eight Central and Eastern European countries (Czech Republic, Estonia,

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Hungary, Latvia, Lithuania, Poland, Slovenia, and Slovakia).¹ The addition of three years of observations for the new members of the European Community, not included in prior analyses, helps to capture the full effects of gas reforms.² Finally, longer time-series, in general, improve the statistical properties of the research.

The contributions of this analysis are threefold. First and foremost, it tests the impact of liberalization and individual regulatory solutions on competition, as a measure of performance not tested in the previous literature. In particular, it intends to answer the question of whether the European gas reforms have reached their major objective. Second, it uses a wider set of liberalization tools than the majority of the empirical research,³ allowing a more comprehensive approach to the problem and reducing the omitted variables issues. Third, it extends the tested sample to Central and Eastern European countries and up to the year 2013, making the paper more current than the available studies of the natural gas industry.

The paper is organized as follows. The next section presents in details the liberalization tools recommended by the European Commission and other EU-based regulatory agencies. Then, the statistical methods used to assess the impact of the policy tools on competition are explained. Next, information on data is presented, followed by the presentation and discussion of the results. To sum up, the final conclusions and policy implications are provided.

2. Liberalization policy tools

The policy tools implemented in the EU member states for the purpose of gas market restructuring are based on the standard regulatory prescriptions for the introduction of competition into the network industries, as advocated by the theoretical literature (Joskow, 1996; Newbery, 2000). They consist of unbundling services of the incumbent, third-party non-discriminatory access to the network, and network access pricing regulation. These general regulations were supplemented with more specific recommendations by the EU. The framework of the European regulatory model presented in Table 1 summarizes the key liberalization issues addressed in the three gas directives and two regulations and their evolution across those main gas documents. They were subsequently translated into the liberalization tools analyzed in the study. Additionally, the analysis considered other essential instruments (like VTP, gas exchanges, gas release programs, lifting gas price controls) that may not have been directly addressed in the directives or regulations but that appear in most significant papers or antitrust actions by EU gas market-dedicated agencies (e.g. EC, ERGEG, ACER, ENTSO). Furthermore, following both research and practice, privatization as a structural solution is also considered.

The selection of liberalization policy tools was based on relevance but also dependent on data availability. The second pre-defined criterion, that is, the availability of information on the implementation of liberalization policy tools in the EU countries in the analyzed period, proved to be challenging. For example, data on implementation of various congestion management procedures (CMP) in the longitudinal format seemed unobtainable at that moment, as the first ACER's monitoring report on that issue,

published in January 2013, indicated the CMP application status as of Q3 2013 only. Additionally, some pro-market measures approved by the European Commission in relation to antitrust proceedings, like the package of commitments by Distrigas for the Belgium market, are unobservable for research purposes, as they involved changes in bilateral supplier-customer contracts over few years. The ten liberalization policy tools and their relevance in the literature are described below.

2.1. Unbundling

Unbundling appears in four general modes that differ in magnitude of economic and legal separation (Künneke and Fens, 2007):

- Administrative (or accounting) unbundling: separate financial accounts for network activities and sales/production, but shared operations under one company;
- Management unbundling: in addition to administrative unbundling, staff are assigned to different business divisions/units that function independently from other business activities, but are still managed from a central holding;
- Legal unbundling: network activities are organized in a separate legal entity, which might, however, function in a holding company together with production and sales activities;
- Ownership unbundling: the former vertically integrated company divests its competitive segment assets and separates from natural monopoly bottleneck segment.

The separation of the market segments of the gas industry was proposed by the EU in stages: starting from the weakest form of accounts separation (accounting unbundling) for transmission, distribution, and storage up to the preference for ownership unbundling of transmission system operators (TSOs) in the third gas directive.

In the literature the last two forms (legal and ownership unbundling) are investigated, as they are easily observable and seem to make a difference, as opposed to the administrative and management unbundling.

The divestiture of transmission networks or key pipelines off vertically integrated incumbent companies was also a measure chosen to terminate some antitrust and merger cases initiated by the European Commission in the gas market. For example, to settle antitrust proceedings, ENI committed to divesting its shares in three international transport pipelines: the TAG, the TENP, and the Transitgas pipeline. Similarly, in reaction to EC's concerns, RWE offered to divest its entire Western German high-pressure gas transmission network. As a remedy to the merger of Gaz de France and Suez, the parties offered the divestiture of Distrigas and SPE and Suez relinquishing its control of Belgian network operator Fluxys.

2.2. Third-party access (TPA) to the gas network

Unbundling is a concept fundamentally associated with open access to infrastructure. The EC distinguished two TPA regimes: negotiated TPA and regulated TPA. Under the negotiated TPA, those willing to conclude a gas supply contract should be able to negotiate the infrastructure access in good faith. The facility owners were bound to publish the main commercial conditions for the use of the system. Nonetheless, the negotiated TPA left the information supremacy and negotiation power in the hands of the incumbent (Haase, 2009). The regulated TPA was a more transparent and pro-liberalization regulatory tool as it necessitates the facility owner to publish not only major terms but, first and foremost, common

¹ Additionally, two Mediterranean countries (Malta and Cyprus) accessed the European Community on that date but they are excluded from the analysis due to non-existent gas markets.

² An exception is the work of Growitsch and Stronzik (2014) who included four Central and Eastern European countries in their sample: Czech Republic, Hungary, Poland, and Slovakia.

³ Only Copenhagen Economics (2005) tested more regulatory solutions than the current study but their analysis ended in 2003, and their sample is limited to Western Europe.

Table 1

The European regulatory model for gas market – the main elements recommended and their evolution in the EU gas directives and regulations.

Regulatory tool	First gas directive (1998)	Second gas directive (2003) and regulation 1557/2005	Third gas directive (2009) and regulation 715/2009
Unbundling			
- TSO	Accounting	Legal	Ownership or ISO
- DSO	Accounting	Legal	Legal
- SSO	Accounting	Accounting	Legal
TPA			
- TSO	nTPA or rTPA	rTPA	rTPA (+ entry-exit model)
- DSO	nTPA or rTPA	rTPA	rTPA
- SSO	Not mentioned	nTPA or rTPA	nTPA or rTPA
Legal market opening	20% of national gas consumption; 28% in 5 years; 33% in 20 years alternatively: 30% of national gas consumption; 38% in 5 years; 43% in 10 years	All non-household customers from 1 July 2004, All customers from 1 July 2007	As before
Independent Regulatory Authority	Not mentioned	Independent national authority required	As before
Balancing rules	Not mentioned	Market-based and non-market-based regimes	Only market-based regime
Capacity management	Not mentioned	Capacity allocation and congestion management basic rules – primary and secondary capacity market by TSO recommended Contractual congestion is an important issue; physical congestion is rare	Capacity allocation and congestion management basic rules – primary and secondary capacity market by TSO recommended Substantial contractual congestion in the gas network recognized; physical congestion is rare

Notes: TSO: transmission system operator; DSO: distribution system operator; SSO: Storage System Operator; ISO: Independent System Operator; nTPA: Negotiated TPA, rTPA: regulated TPA.

tariffs. Since implementation of the second gas directive, the regulated TPA has been the preferred form of regulating the access to transmission and distribution gas networks in the EU.

2.3. Market opening

The opening of the market was defined as the share of the “eligible” gas customers (expressed in volumetric terms) who acquired the rights to the Third Party Access to gas infrastructure and to change gas suppliers. The EU gas directives specified who should at least be qualified for eligibility and the gradual opening of the market (see Table 1 for the detailed timeline). Since July 1, 2007 all of the EU gas market has been open, except for the countries granted derogations.

2.4. Independent regulatory authority (IRA)

The second Gas Directive introduced a requirement for member states to establish regulators with specific competencies, wholly independent of the interests of the gas industry. The IRAs were expected at least to be responsible for ensuring non-discrimination, effective competition, and the efficient functioning of the market and monitoring.

2.5. Balancing rules

Unbundling of gas transportation from trading activities had a side effect in terms the need for reorganization of network system balancing rules. In the vertically integrated gas industry, gas-flow management was steered centrally. The carved-out transmission and distribution system operators faced a new challenge of assigning the responsibilities for an unbalanced system and of setting the system-friendly incentives. The EU set a preference for market-based balancing mechanisms wherever there was a sufficiently liquid gas market. In the absence of such a liquid market, national regulatory authorities should ensure that balancing tariffs were non-discriminatory and cost-reflective.

2.6. Virtual trading point (VTP)

The EU promoted the Gas Target Model, which was a structural framework that set out how a functioning European gas market should emerge. The model was a vision of the competitive European gas market, comprising entry-exit zones with liquid virtual trading points, where market integration was served by appropriate levels of infrastructure, which was utilized efficiently and enabled gas to move freely between market areas to the locations where it was most highly valued by gas market participants (ACER, 2015). The entry-exit zones were a prerequisite for VTPs, where the OTC market could start functioning. The liquid market, on the other hand, was essential for a transparent price discovery mechanism, which was a precondition for market-based balancing in the gas networks.

2.7. Gas exchange

Setting up a gas exchange was usually a further evolutionary step in spot gas market development (e.g., in Germany), but it may have also been a consequence of a regulatory decision intended to speed up the liberalization process (like in Poland or Lithuania). The creation of spot and future markets for gas is the decisive regulatory innovation that allows for supplementing (and partly substitute for) the less flexible system of long-term contracts (Newbery, 2000). The third gas directive imposed an obligation on national TSOs and IRAs to facilitate and promote the creation of natural gas exchanges.

2.8. Gas release program

Gas release programs were designed to force an incumbent company to resell gas to its competitors on a wholesale level and on pre-defined terms to allow for competition on a retail level. The European Commission imposed the obligation to conduct the gas release programs after competition analyses on a few mergers in the gas industry, for example, after acquisition by DONG of Danish electricity generators and suppliers. Some countries conducted the gas release programs voluntarily to speed up the liberalization process.

2.9. Lifting gas price controls

In pre-liberalization times gas prices were usually subject to regulation or control by a public authority, as opposed to prices determined exclusively by supply and demand. To mitigate the market power of the monopoly, price regulation needed to be maintained, but this often harmed the interests of (potential) new entrants (Correljé and De Vries, 2008). Thus, the EU required that the member states would lift gas price controls to allow for the development of competition.

2.10. Privatization

Although the European Commission was not in power to influence shareholder structures of companies, restructuring of network industries often involved the question on the privatization of state-owned incumbent companies. If the government monopoly was the ultimate and traditional form of regulation (Genoud et al., 2004), then privatization was a way of industry deregulation. Public ownership was reputed as inherently inefficient by some economists. Thus, privatization usually but not inevitably accompanied liberalization, as it was hard to imagine that effective and efficient competition was sustainable in the public sector (Newbery, 2000). The empirical evidence supporting the advantages of private ownership is generally unambiguous (see the review by Ricketts, 2002).

3. Methodology

To assess the effects of liberalization tools and privatization on competition in the European gas markets, dynamic panel data analysis was employed. The longitudinal analysis exhibits several benefits, which makes it superior to traditional cross-section and time-series studies in terms of controlling for individual heterogeneity, more informative data, more variability, less collinearity among variables, more degrees of freedom, more statistical efficiency, and the ability to better study the dynamics of adjustment (Baltagi, 2008). Following some preceding studies utilizing the panel data models (e.g., Blundell and Bond, 2000; Bond et al., 2003; Brau et al., 2010; Fiorio and Florio, 2013), simple AR(1) models using OLS, fixed-effects and GMM were performed to check the autoregressive properties of the switching rate, which proxied for competition in the current empirical study.

There was a strong evidence of the dependent variables following the AR(1) process (see Table 2) and the lagged dependent variable, explaining the strong past persistence, was included among regressors. Given the high correlation between the output variables and their lags, the static panel models would introduce a serious bias in estimations. Moreover, inclusion of the lagged dependent variable was coherent with the observed path-dependency of the restructuring process in the European gas and electricity industries, and it incorporated the impact of country's starting position (Correljé and De Vries, 2008; Erdogdu, 2013; Opolska and Jakubczyk, 2013). The following basic dynamic panel

data equation was estimated to test the impact of liberalization tools and privatization on competition:

$$y_{i,t} = \alpha y_{i,t-1} + \beta R_{i,t} + \gamma C_{i,t} + \delta_t + \mu_i + \varepsilon_{i,t},$$

where $y_{i,t}$ was a measure of competition for a country i at time t . $y_{i,t-1}$ was the lagged dependent variable for a country i at time $t-1$. $R_{i,t}$ was a set of liberalization tools or liberalization index, $C_{i,t}$ was a set of control variables. The parameter vectors α , β , and γ were to be estimated. Control variables were log-transformed to interpret coefficients as elasticities, and also to reflect a plausible assumption on the multiplicativity rather than the additivity of variables. As a result, it improved the fit of the regression model. The term μ_i captured the unobserved heterogeneity across countries and $\varepsilon_{i,t}$ was the error term satisfying the usual assumptions. Time dummies (δ_t) were included in the model specification to account for common trends. Time dummies reduced the possibility of violations of the assumption of no correlation across countries in the idiosyncratic disturbances in autocorrelation tests and robust estimates of the coefficient standard errors (Roodman, 2009).

The regressors and the independent variable were assumed to be interdependent, as the switching rate was usually one of the key parameters used to assess the level of competition in energy industries by governmental bodies, independent regulators or competition authorities. Hence, low switching rates might trigger a feedback reaction and provoke new regulatory solutions. To account for the assumed feedback loop, the $R_{i,t}$ vector was allowed to correlate with the unobserved error term, that is, it was considered endogenous in the base model. However, for comparison⁴ and for robustness check of results under different assumptions ($R_{i,t}$ as predetermined or as exogenous) alternative models were assessed.

Estimation of the dynamic longitudinal models was not without some econometric problems. The main issue was that the lagged dependent variable was, by construction, correlated with the individual effects. This rendered the pooled ordinary least-squares estimator biased and inconsistent (Ruyssen et al., 2014). A within transformation and the resulting fixed-effects estimators were only consistent when both T (time) and N (number of panels) would go to infinity. Nickell (1981) proved serious biases in the coefficients if T was fixed. Given that the (asymptotic) bias might be quite sizable in many cases relevant to applied research, various alternative estimators were proposed. The generalized method of moments (GMM) estimators in general, and the differenced GMM (Arellano and Bond, 1991) and the system GMM (Arellano and Bover, 1995; Blundell and Bond, 1998) in particular, were among the most popular approaches. The advantage of the differenced and system GMM estimators was that they were consistent for finite T and large N . Blundell and Bond (2000) found, however, that the differenced GMM models might potentially suffer from weak-instruments biases when using persistent series. They concluded that system GMM that used extra moment conditions performed better than the differenced GMM and produced consistent and efficient estimates. Hence, their one-way system Generalized Method of Moments was used here as the basic statistical approach to test the research hypothesis.

Another problem with longitudinal data was a possible autocorrelation or cluster-correlation. The assumption of independence

Table 2
AR (1) models using OLS, fixed-effects and GMM.

	OLS	FE	GMM
Lag(1) of Switch rate	0.913***	0.750***	0.861***

Notes: Dependent variable: switching rate.

Lag(1) of Switch rate: switching rate variable lagged by one year.

Standardized beta coefficients. Time dummies included. GMM results are one-step system estimates with heteroscedasticity-robust standard errors.

***, **, * Significance at the 1%, 5% and 10% level, respectively.

⁴ Fiorio and Florio (2013) assume the regulatory variables are predetermined, as that, "due to the political and decisional process involved, they react with some lag to changes in the error term". Growitsch and Stronzik (2014) model all regulatory variables as endogenous, as modeling them "as strictly exogenous leads to a rejection of the Sargan test, indicating that regulatory reforms—at least partly—have been driven by high end-user prices for households." Brau et al. (2010) treat regulatory indicators as strictly exogenous.

of observations might be violated in the case of the dataset; thus, a robust variance estimator that allowed for heteroscedasticity between and within clusters and for serial correlation was used.

The robustness of the GMM models was checked with the [Arellano and Bond \(1991\)](#) autocorrelation test for assessing whether there was a serial correlation in the first-differenced errors.

The system GMM estimators were asymptotically unbiased when N tended to infinity and T was fixed, but the use of an instrumental variables technique often lead to poor small sample properties ([Bun and Kiviet, 2006](#); [De Vos et al., 2015](#); [Everaert and Pozzi, 2007](#); [Ziliak, 1997](#)). With the moderate-sized dataset of 22 countries and a limited time-series of 16 years, the current study might face small sample size issues. In the literature, as a remedy to this problem, a few analytical bias-corrections for the FE estimator were proposed by, among others, [Bruno \(2005a, 2005b\)](#), [Bun and Carree \(2005\)](#), [Bun \(2003\)](#), [Everaert and Pozzi \(2007\)](#), [Kiviet \(1995\)](#). With the unbalanced nature of dataset, the practical applications of the advanced corrected FE estimators were limited to two corrections⁵ by [Bruno \(2005a, 2005b\)](#) for the so-called LSDV estimator, and by [Everaert and Pozzi \(2007\)](#) with the extension and application of [De Vos et al. \(2015\)](#) for the so-called BCFE estimator. The advantage of these estimators was that they reduced the bias of the FE estimator and had superior small sample properties compared to GMM estimator. The downside was their inapplicability in the presence of endogenous, or even only weakly exogenous, regressors.

As none of the above dynamic panel data methods (system GMM, Bruno's corrected LSDV, bootstrap-based bias-corrected FE by Everaert, Pozzi and De Vos) were without drawbacks, the assessment of the impact of liberalization tools on prices and competition in the gas industry was executed using all three specifications for robustness check.

Finally, as a further robustness check and for the sake of comparison with the previous studies involving the Western European countries only, the models were tested on a sample of 14 countries that were a part of the old EU-15.⁶ Following the example of [Growitsch and Stronzik \(2014\)](#) long-run multipliers in a partial adjustment model were also calculated to identify the long-term impact of liberalization tools on competition:

$$\beta' = \frac{\beta}{1 - \alpha}$$

4. Data and variables

The unbalanced dataset included information on 22 European Union member states, including eight Central and Eastern European countries that joined the Community on May 1, 2004, and the liberalization progress in their gas industries between 1998 and 2013. The country selection was based on the membership status in the EU before 2005, the existence of a domestic gas industry and data availability. The choice of the time-series starting date was dictated by the first Gas Directive that initiated gas reforms in most

of the EU member states.

The major data source for the liberalization tools were annual reports submitted by national regulatory authorities to the Council of European Energy Regulators and available to download on its website. In addition, the websites of national regulators were also an educational source for supplementary information. The history of ownership structures of national incumbents was mainly acquired from corporate annual reports and websites. The majority of related empirical studies relied on the OECD indicators for regulation energy, transport, and communications. The advantage of the OECD source compared to the present "patchwork" dataset was its consistency. The disadvantage was that the OECD detailed regulatory time-series were available only up to 2007 and they covered basic regulatory instruments. The recently published update was indeed up to 2013, but it was available exclusively on an aggregated level in yearly time intervals or on a detailed level in five-year intervals, which either way would mean a loss of information important for the current study.

The proxy for increased competition was the switching rate. Customer switching behavior is an important indicator of a competition level in an industry. Low switching activity may imply the influence of high switching costs and barriers to competition ([Waterson, 2003](#)). High switching costs in turn may give firms a degree of market power ([Klemperer, 1995](#)). Hence, liberalization tools that help to ensure consumers are well informed and able to switch their service provider stimulate vibrant, enduring competition ([Armstrong and Sappington, 2006](#)). Supplier switching was well examined in the electricity market (e.g., [Defeuille, 2009](#); [Gamble et al., 2009](#); [Yang, 2014](#)) but empirical research in the gas industry was lacking.

Although switching rates are widely applied as a measure of competition in energy industries (e.g., by national energy regulators, by European agencies like ACER/CEER or NordREG in their annual reports, by energy think tanks like VaasaETT in their World Energy Retail Market Rankings or OXERA in their reports for UK's Department of Trade and Industry), it assesses only one aspect of a competitive environment: customer behavior. Thus, it has its limitations in providing a full picture of industry's competition level. Switching rates indicate the percentage of active customers who executed their rights to move to another gas provider, but they do not account for the fact that there is a group of active clients who renegotiated their contracts and stayed over ([Defeuille, 2009](#)). Switching does not automatically grow over time and in an extreme case of perfect competition, homogenous goods and fully aware customers no switching takes place, as every supplier offers competitive prices and conditions ([Waterson, 2003](#)). Client switching is also affected not only by market structure or monetary motivation but also by individual psychological aspects ([Ek and Söderholm, 2008](#); [Gamble et al., 2009](#); [Yang, 2014](#)) that are independent of a regulatory regime in a country. For the purpose of the study, however, the drawbacks of the switching rate are outweighed by its advantages: its popularity and wide acceptance among researchers, its availability in the panel data form for analyzed countries, its relative rather than absolute meaning for tested liberalization tools.

All variables are described in [Table 3](#). Nine out of eleven policy variables are dummies, except for the quantitative market opening and privatization variables. Signs of coefficients of the independent variables, as expected by the theory, logics or previous empirical research, are also presented in the last column. The exact method of calculating each variable is defined in the third column. All possible values for each dummy variable are presented together with their explanations.

In addition to the regulatory variables, described in [Section 2](#), two control variables were included in the analysis. The first was

⁵ The biased-corrected LSDV derived by [Bruno \(2005a, 2005b\)](#) was applied by [Growitsch and Stronzik \(2014\)](#) to their empirical analysis on the effect of ownership unbundling of gas transmission networks on the level of end-user prices. To author's best knowledge the bias correction of FE estimator by [Everaert and Pozzi \(2007\)](#) was not previously used to studies on the effect of regulatory tools on gas or electricity prices.

⁶ Included are Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Sweden, Spain, and United Kingdom.

Table 3
Definitions of variables.

Variable	Variable's symbol	Definition of variables	Expected sign
Switching rate	<i>y</i>	A number of customers who switched a gas supplier within a year, scaled by the total number of gas customers in a given country	
TSO unbundling	<i>R</i>	Type of unbundling of the largest TSO in the country: 2- ownership unbundling, 1 - legal unbundling, 0 - management/accounting or no unbundling	+
DSO unbundling	<i>R</i>	Type of unbundling of the largest DSO in the country: 1- ownership or legal unbundling, 0 - management/accounting or no unbundling	+
TPA rules	<i>R</i>	Terms and conditions of the third party access to the TSO network: 2-regulated TPA, 1 - negotiated TPA, 0 - no TPA	+
Market opening	<i>R</i>	Volume of gas consumption by eligible customers, expressed in percentage of the total demand. If customers acquired their eligibility rights during a given year, the degree of market opening is calculated proportionally to the number of months, in which the eligibility was in force	+
Regulator	<i>R</i>	Is there a national independent regulatory authority established in a country? 1 - yes, 2 - no	+
Market balancing	<i>R</i>	Are TSO's charges for system imbalances related to market prices? 1 - yes, 0 - no	+
Price controls	<i>R</i>	Are end-user gas prices subject to regulation by a public authority? 2 - no, all prices are determined by the market; 1- yes, some prices are regulated; 0 - all prices are regulated	+
VTP	<i>R</i>	Is there a virtual trading point established on the TSO network in a country? 1 - yes, 0 - no	+
Gas exchange	<i>R</i>	Is there a gas exchange established in a country? 1 - yes, 0 - no	+
Gas release	<i>R</i>	Is a gas release program conducted in a country in a given year? 1- yes, 0 - no	+
Privatization	<i>R</i>	Private (non-state) share in the shareholder structure of a national incumbent gas supplier at the end of the year	?
Liberalization index	<i>R</i>	An aggregated measure of all regulatory variables summed up into one number. Each regulatory tool is equally weighted in the index	+
Gas production	<i>C</i>	Domestic gas production per capita expressed in Tj/p.c.	+
Import structure	<i>C</i>	Herfindahl–Hirschman Index (HHI) calculated on market shares of countries exporting gas to a given market	–

Notes: Definition of variables: For dummies the meaning of each possible value assumed is explained.

Expected sign of the coefficient: “+” as expected; “–” contrary to expectation; “?” no expectations.

country's natural gas production. Country's natural gas resources base might drive not only local competition but also propensity towards regulatory change (Arentsen and Kunneke, 2003). Natural gas was scarce in Europe; hence, resistance to horizontal unbundling was sometimes linked to concerns about fuel import dependency (Correljé and De Vries, 2008). While the gas production variable indicated import dependency, the import structure variable (the second control) showed the degree of gas suppliers' diversification. The expectation is that the more diversified is country's portfolio of gas supplies, the higher is the potential for competition. The import structure variable also served as a proxy for capacity management information, which is of paramount importance for competition but is very limited in the panel data format for the analyzed countries in the tested period. Accessible and vast entry capacity at various gas import interconnectors is a prerequisite to foster diversification of gas importers.

5. Results and discussion

Table 4 presents the results of the estimation of the effects of the liberalization tools on the competition both in the short and long run.⁷ The first column reports the basic GMM model for the EU-22 countries, in which the policy variables were assumed endogenous. Six out of the eleven liberalization policy tools (privatization included) had statistically significant coefficients at the 0.1 level or smaller. Only the gas release program had a counterintuitive and decreasing impact on competition, but since it was not confirmed by any other specification, the correlation might be spurious. Four policy tools were found significant in more than just the basic GMM model: market opening, market balancing, VTP, and privatization.

Market opening designated the start date at which some customers, at least legally, become eligible and able to switch suppliers. The positive and significant relationship with the switching

rate proved that once gas customers acquired the legal right to change gas supplier, they were usually able to execute it effectively. Results were sounder in the Western European countries, but were not preserved in the long run. Interestingly, the previous studies that investigated the relationship between gas prices and liberalization found that the impact of opening the market was insignificant and ambiguous (Brau et al., 2010; Florio, 2013; Growitsch and Stronzik, 2014). Hence, the legal market opening might introduce some competition in the marketplace, but it did not automatically lead to lower gas prices.

Market balancing showed some competition-enhancing potential, significant at the 0.1 level. The European Federation of Energy Traders (EFET) position paper on market balancing (EFET, 2008) offered some insights on how the balancing regime translated into increased competition. It postulated that the design of balancing rules and associated arrangements impacted the risks faced by gas shippers and might have created real barriers to entry, particularly in the early stages of liberalization. New players entering the gas market encountered high costs for imbalanced positions in the gas network. Little or no portfolio diversification put them at a disadvantage to the incumbent firm that could easily manage its position in a large customer base. Unless the balancing regime was transparent and market-based the risks and increased costs might deter entry of new market players. The present empirical results proved it to be of importance for the competition in the gas sector, and this effect was partially sustained in the long run for the Western European countries.

Market-based balancing was usually preceded by the creation of virtual trading hubs where network users had the possibility to bilaterally transfer title of gas and/or swap imbalances. Virtual trading points showed evidence to foster competition in the gas sector in both short and long run in the current analysis. This is in line with the conclusions that Alonso et al. (2010) drew for the Spanish gas transportation system under entry-exit system regime. As the creation of virtual hub was accompanied by a move towards an entry-exit system of network tariffs, benefits of the latter intertwined with those of VTPs.

⁷ The long-run multipliers are presented only for the variables that are statistically significant in the basic GMM models with endogenous regulatory variables.

Table 4

Estimation of dynamic panels testing the impact of liberalization tools on competition.

Model	GMM	GMM	GMM	LSDVC	BCFE	GMM	GMM	GMM	LSDVC	BCFE
Countries	EU-22	EU-22	EU-22	EU-22	EU-22	EU-14	EU-14	EU-14	EU-14	EU-14
Regulatory variables	endogenous	predetermined	exogenous	exogenous	exogenous	endogenous	predetermined	exogenous	exogenous	exogenous
Lag (1) of Switch rate	0.675*** (0.116)	0.734*** (0.109)	0.648*** (0.161)	0.676*** (0.068)	0.541*** (0.107)	0.668*** (0.122)	0.675*** (0.134)	0.575*** (0.161)	0.641*** (0.095)	0.523*** (0.128)
TSO unbundling	0.013 (0.003)	0.014 (0.003)	0.064 (0.003)	−0.047 (0.005)	−0.01 (0.004)	−0.054 (0.003)	−0.068* (0.003)	−0.002 (0.006)	−0.147 (0.010)	−0.144 (0.008)
DSO unbundling	0.031 (0.004)	0.051 (0.004)	0.023 (0.004)	0.033 (0.006)	0.022 (0.005)	−0.01 (0.006)	0.039 (0.005)	0.014 (0.009)	0.044 (0.011)	0.057 (0.008)
TPA rules	0.074* (0.003)	0.057 (0.003)	0.077 (0.005)	0.063 (0.004)	0.027 (0.003)	0.069 (0.005)	0.073 (0.005)	0.086 (0.005)	0.011 (0.008)	−0.031 (0.017)
Market opening	0.095* (0.007)	0.101* (0.007)	0.142* (0.010)	0.061 (0.011)	0.004 (0.007)	0.129*** (0.007)	0.130*** (0.006)	0.150 (0.016)	0.141 (0.025)	0.094 (0.027)
Regulator	0.015 (0.004)	0.051** (0.004)	0.035* (0.003)	0.053 (0.008)	0.02 (0.005)	0.029 (0.007)	0.056* (0.007)	−0.028 (0.009)	0.051 (0.012)	0.047 (0.014)
Market balancing	0.066* (0.006)	0.045 (0.006)	0.052 (0.011)	0.091 (0.012)	0.089 (0.012)	0.104* (0.009)	0.093* (0.009)	0.022 (0.018)	0.134 (0.017)	0.115 (0.017)
Long-run effect	0.043 (0.032)	0.040 (0.036)	0.030 (0.045)	0.046 (0.037)	0.036 (0.029)	0.066** (0.026)	0.061** (0.027)	0.010 (0.049)	0.064 (0.052)	0.046 (0.038)
Price controls	0.007 (0.004)	−0.023 (0.004)	−0.005 (0.007)	0.047 (0.006)	0.094 (0.005)	−0.104 (0.006)	−0.151* (0.007)	−0.129 (0.012)	−0.004 (0.020)	−0.116 (0.018)
VTP	0.135*** (0.005)	0.089*** (0.004)	0.184 (0.015)	0.072 (0.009)	0.095 (0.009)	0.082** (0.006)	0.069** (0.004)	0.190* (0.016)	0.068 (0.014)	0.081 (0.013)
Long-run effect	0.070** (0.033)	0.062* (0.038)	0.085** (0.041)	0.030 (0.032)	0.031 (0.023)	0.043 (0.029)	0.037* (0.022)	0.072** (0.031)	0.028 (0.042)	0.027 (0.031)
Gas exchange	0.030 (0.003)	0.074** (0.004)	0.099** (0.006)	0.059 (0.008)	0.031 (0.006)	−0.026 (0.006)	−0.017 (0.007)	−0.070 (0.014)	0.021 (0.011)	−0.028 (0.008)
Gas release	−0.038* (0.004)	−0.03 (0.004)	−0.010 (0.007)	−0.02 (0.008)	−0.031 (0.010)	−0.024 (0.004)	−0.009 (0.006)	−0.029 (0.007)	−0.010 (0.011)	−0.012 (0.026)
Long-run effect	−0.031* (0.016)	−0.033 (0.024)	−0.008 (0.024)	−0.012 (0.024)	−0.016 (0.027)	−0.018 (0.016)	−0.007 (0.023)	−0.016 (0.021)	−0.006 (0.033)	−0.006 (0.062)
Privatization	0.097** (0.007)	0.103** (0.008)	0.221* (0.023)	−0.026 (0.014)	−0.007 (0.008)	0.195 (0.025)	0.220 (0.027)	0.351 (0.043)	−0.158 (0.034)	−0.053 (0.057)
Long-run effect	0.068* (0.040)	0.098* (0.052)	0.139*** (0.053)	−0.015 (0.045)	−0.003 (0.020)	0.147*** (0.047)	0.171*** (0.033)	0.191*** (0.051)	−0.091 (0.104)	−0.025 (0.136)
Gas production	−0.010 (0.000)	0.023 (0.000)	0.021 (0.000)	1.128*** (0.001)	0.459 (0.001)	0.150** (0.000)	0.158*** (0.000)	0.269** (0.000)	0.616* (0.001)	0.442 (0.003)
Import structure	0.046 (0.003)	0.044* (0.002)	0.098* (0.005)	0.145* (0.007)	0.085 (0.018)	0.104*** (0.003)	0.107*** (0.002)	0.129** (0.005)	0.192 (0.011)	0.210 (0.023)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	250	250	250	250	240	158	158	158	158	148
ar1p	0.027	0.042	0.086			0.077	0.118	0.195		
ar2p	0.345	0.318	0.331			0.143	0.130	0.135		

Notes: Dependent variable: switching rate.

Lag(1) of Switch rate: switching rate variable lagged by one year.

EU-14: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Sweden, Spain, and United Kingdom.

EU-22: EU-14 plus Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia.

Standard errors in parentheses are robust to heteroscedasticity and to within group serial correlation. ar1p and ar2p report the p-values of tests for first-order and second-order serial correlation, asymptotically N(0,1) under the null of no autocorrelation.

Long-run effect: long-run multipliers in a partial adjustment model calculated to identify the long-term impact of liberalization tools on competition. Only statistically significant coefficients are shown in the table.

GMM results are one-step system estimates with heteroscedasticity-robust standard errors. Instruments used in all GMM equations include dependent variables at lags t-3 or earlier, the regulatory variables (if assumed endogenous then lags t-2 and earlier, if assumed predetermined then lags t-1 and earlier), and exogenous variables.

LSDVC: initialized with the Blundell and Bond (1998) estimator (BB), standard errors calculated via bootstrapping (250 runs).

BCFE: standard errors calculated via wild bootstrap resampling (250 runs), burn-in initialization scheme for the bootstrapped lagged dependent variables.

Variables definitions: see Table 3.

***, **, * Significance at the 1%, 5% and 10% level, respectively.

The privatization variable was found to have a statistically significant and positive coefficient, suggesting more switching in privatized gas markets. This effect diminished in the short run for the EU-14 countries but stayed soundly significant in the longer term. The results are similar to the outcome by Stagnaro (2014) for the energy industry who provided evidence that mostly privatized industries tended to be associated with the incumbents having lower market shares.

The results of the two bias-corrected LSDVC and BCFE models for both samples (EU-22 and EU-14) suggest irrelevance of liberalization policy tools to competition. The LSDVC and BCFE models, however, did not control for an endogenous character of

liberalization regressors, which seemed of paramount importance to the relationship between regulatory policy and switching. The importance of the endogeneity assumption was upheld by the results of the three GMM model specifications, differing in assumed properties of regulatory variables. In a few cases, the coefficients ceased to be significant if the liberalization policy variables were treated as exogenous. Additionally, it mattered if the liberalization tools were considered predetermined or endogenous, as results were impacted differently. The GMM models for EU-22 and EU-14 passed key identification tests allowing for zero second-order autocorrelation of residuals, as well as the Wald test rejecting the null hypothesis that all coefficients except constant were zero.

Table 5

Estimation of dynamic panels testing the impact of liberalization index on competition.

Model	GMM	GMM	GMM	LSDFC	BCFE	GMM	GMM	GMM	LSDFC	BCFE
Countries	EU-22	EU-22	EU-22	EU-22	EU-22	EU-14	EU-14	EU-14	EU-14	EU-14
Regulatory variables	endogenous	predetermined	exogenous	exogenous	exogenous	endogenous	predetermined	exogenous	exogenous	exogenous
Lag (1) of Switch rate	0.683*** (0.124)	0.703*** (0.117)	0.677*** (0.173)	0.745*** (0.063)	0.605*** (0.119)	0.706*** (0.110)	0.715*** (0.112)	0.655*** (0.125)	0.733*** (0.086)	0.613*** (0.142)
Liberalization index	0.510*** (0.002)	0.433** (0.002)	0.528*** (0.004)	0.227*** (0.001)	0.206*** (0.001)	0.334*** (0.002)	0.358*** (0.003)	0.436** (0.003)	0.196 (0.003)	0.123 (0.002)
Long-run effect	0.034** (0.016)	0.032** (0.016)	0.035** (0.016)	0.015** (0.007)	0.010*** (0.004)	0.029*** (0.009)	0.032*** (0.012)	0.030*** (0.007)	0.015 (0.012)	0.007 (0.006)
Observations	250	250	250	250	240	158	158	158	158	148
ar1p	0.0761	0.0972	0.1367			0.2248	0.2277	0.2319		
ar2p	0.1681	0.1790	0.1647			0.1263	0.1180	0.1143		

Unbundling of the gas network was the fundamental proposition of the European Union intended to accomplish the gas and electricity reforms objectives. Hence, the empirical evidence of its irrelevance to competition is not unprecedented. Similar results with regard to gas prices were found by [Copenhagen Economics \(2005\)](#), [Brau et al. \(2010\)](#) and [Florio \(2013\)](#). Related studies in the electricity sector had mixed results.⁸ A possible and likely explanation, confirmed by the empirical results presented in [Table 5](#), is that unbundling alone might not bring the desired results but still support the liberalization process and strengthen the impact of other policies ([Pollitt, 2008](#)). An incomplete liberalization process, which lacks an effective regulatory framework, does not bring desired effects ([Dorigoni and Portatadino, 2009](#)). The liberalization tools aggregated by simple addition in the liberalization index were robustly significant in all model specifications tested on the full sample of 22 EU members. The robustness check on the Western EU-14 countries confirmed the results in all GMM models. Some of the competition-enhancing impact was maintained in the long run. Hence, the higher the number of implemented liberalization tools, the higher the switching rate. The results were robust to the Wald test and the Arellano-Bond test of zero second-order order autocorrelation of residuals in the GMM model.

Finally, two control variables included in the models provide additional insight. Gas production proved significant at the level of 0.1 or smaller in the sample of Western European countries. Gas-rich Western European countries seemed to have more competitive gas markets. This effect was not preserved when tested on the entire sample of EU-22. The reason might be related to the fact that the Eastern and Central European countries suffered more from a paucity of natural gas resources than their Western European counterparts during the study period, limiting the testability of the gas endowment and diluting its impact.

The degree of country's gas portfolio diversification, proxied by the import structure variable, also appears relevant to gas customer switching activity. However, contrary to some expectations, the less diversified was countries' gas portfolio, the more competitive was the gas market. Although the results were somewhat counterintuitive, they might indicate an intensified effort by governments in countries dependent on one or two gas suppliers to restructure their national gas markets.

6. Conclusions and policy implications

Liberalization of the natural gas sector has been on the European

Commission agenda for almost two decades. During such a long period of restructuring, the means may have become more important than the ends. The current study checked if the ends (competition) were in fact induced by the means (liberalization policy tools).

Taken together, these empirical results suggest that liberalization and the implementation tools chosen by the European Union, positively influenced competition in the gas markets, although jointly rather than on a stand-alone basis. As a general rule, the more pro-market regulations were implemented, the more competitive was the natural gas sector. The study confirms the importance of a holistic and integrated approach to the liberalization process. Only countries with the means to effectively implement many liberalization tools are likely to succeed in bringing meaningful competition to the marketplace. Partial deregulation may result in little or no effect on the structure or performance of the gas market.

The greatest competition-enhancing potential was found in those liberalization policy instruments that increased wholesale market liquidity and lowered entry barriers related to gas network (VTP, market-based balancing, and market opening). For authorities in charge of market deregulation, this translates into the need for increased effort on creating the common market platform, where the rules are market-based and non-discriminatory for new players on the supply side and promote access by ex-incumbent customers on the demand side. In addition, privatization seemed to activate competitive behavior of customers and its effect was sustained in the long run. In contrast, national gas markets where the government remained the key shareholder in an incumbent gas supplier experienced lower levels of competition. Governments that simultaneously try to protect their national presence on the one hand and open markets on the other face a conflict of interest that may undermine market liberalization.

This study contributes to the empirical research on the impact of reforms on utility performance. While scholars have examined the telecommunication and electricity sectors in this respect, the empirical evidence for the natural gas industry is modest, and an up-to-date evaluation of the impact of liberalization policy tools fills a gap in the literature.

The analysis has some practical implications. Although it related to the European-style gas market liberalization, the tested regulatory instruments are applied elsewhere and in other industries. Gas markets restructuring in the European Union was a unique top-down policy experiment that constituted a great proving ground for testing the regulation-competition interdependence. The findings are relevant to theoreticians, in terms of testing their ideas, but also to policymakers, regulators, and practitioners. The EU, international agencies, and policy advisors may find the paper informative while reckoning the effects of the policy tools or setting up

⁸ For example: [Copenhagen Economics \(2005\)](#) finds unbundling of TSO significant and price-decreasing (industrial consumers), while [Florio and Florio \(2013\)](#) find it insignificant in relation to households prices.

future policy directions for the energy sectors. Finally, the findings contribute to the long and ongoing debate about ownership and lends some support to proponents of the pro-market function of privatization.

Future research is encouraged on the relationships among liberalization, privatization, and competition in the EU gas market, especially as the timeframe grows longer and more countries are available for analyses (e.g., Bulgaria, Romania, and Croatia) and as econometric methods allow for better estimation. If data on more elements of the European gas market model becomes available for research (e.g., entry-exit capacities or congestion management), examining the impact of these factors on competition will be valuable. The study was the first attempt to assess the impact of liberalization on competition in the EU natural gas market. The study was limited to switching rates as a proxy for competition and it did not assess its impact in terms of price or service quality. Future research could test the effect of EU liberalization policy tools on other measures of competition as well as outcomes.

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