EFRI Exclusive Working Papers 2015-003

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Nela Vlahinić Lenz*

* Faculty of Economics, University of Rijeka, Croatia

This research was supported by the
Faculty of Economics, University of Rijeka
https://www.efri.uniri.hr/en
ISSN:

Faculty of Economics, University of Rijeka
I. Filipovića 4, 51000 Rijeka, Croatia

EFRI WORKING PAPER SERIES

ECONOMIC EFFECTS OF ENERGY SECTOR REFORMS ON ELECTRICITY GENERATION: THE CASE OF EU AND SELECTED SOUTHEAST EUROPEAN COUNTRIES[1]

Nela Vlahinić Lenz*
University of Rijeka, Faculty of Economics, Rijeka, Croatia
E-mail: nela@efri.hr

Vedran Prša
Elektroprivreda BiH, Bihać, Bosnia and Herzegovina
E-mail: vedranpra@yahoo.com.

Abstract

The aim of this research is to investigate the impact of energy sector reforms on electricity generation, installed electricity generation capacity and transmission and distribution losses by using the panel regression model with fixed effects. The paper also aims at clarifying whether the impact of energy sector reforms on generation efficiency differs among countries according to their level of development and regional characteristics. Our hypothesis is that energy sector reforms in the European Union and selected SEE countries have a significant impact on electricity generation and electricity transmission and distribution losses, but that these effects are statistically more significant in the EU-15 (old Member States) than in the EU-12 (new EU Member States) and selected SEE countries. We also analyze the interaction effects of individual steps in electricity sector reforms on electricity generation and electricity transmission and distribution losses.

The research results show that unlike in the EU-15 countries, energy sector reforms in the EU-12 and selected Southeast European countries have no significant impact on electricity transmission and distribution losses. When we applied the interaction variables, we found the results rather unexpected since the unbundling of electricity activities in interaction with privatization and regulatory agencies have a negative impact on efficiency indicators in electricity generation and even increase transmission and distribution losses.

Key words: energy sector reforms, electricity generation, transmission and distribution losses, EU, Southeast Europe

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[1] When citing this paper please refer to altered and modified version of this paper: Vlahinić Lenz, N., Prša, V. (2015), Growth potential of energy sector reforms: new evidence on EU and Southeast European countries by exploring impact on electricity generation, Proceedings of Rijeka Faculty of Economics: Journal of Economics and Business, Vol.33, No.2, pp.275-297.

1. Introduction

Long term, sustainable economic growth needs a sustainable electricity supply. In order to accomplish this goal, good economic governance incorporating energy policy should implement reforms that will increase economic efficiency and social prosperity. Improvement in efficiency constitutes one of the main aims in any electricity sector reform program. It is typically argued that, even in the short run, the reform process introduces competition, which in turn encourages economic units with the lowest costs to operate in the market. Over the longer-term period, the market presents better incentives for new entrants; and new entrants with more efficient technologies place additional upward pressure on efficiency levels (Erdogdu, 2011). Overall, it is expected that the introduction of reforms in the electricity sector leads to higher efficiency levels.

A reform process is a set of multidimensional activities with interacting factors and impacts. At one level, reform measures involve structural and organizational changes in the energy sector, while at another, broader, level they aim to establish the appropriate institutional setting such as legislation and new regulatory agencies. Although there are differences in individual reforms across the world, the EU Member States have implemented the same reform model. Generally, it involves a combination of key elements: 1) regulatory reforms and the establishment of an independent regulatory authority, 2) restructuring (vertical and horizontal unbundling), 3) market liberalization (competition on the wholesale and retail market) and 4) privatization (new entries by private firms and privatization of state companies).

The reforms in the sector started in the early 1990s, which has limited the existing literature due to the relatively short span of time, especially in econometric studies that require a large number of observations. Moreover, the literature lacks adequate cross-testing of most of the hypotheses and lacks data conducting appropriate panel-data analysis. Therefore, there is a strong need for a new systematic analysis that would include the EU countries and the Southeast European countries in addition to a broader range of issues related to energy sector reforms within a longer time frame.

The aim of this research is to investigate the impact of the reforms conducted in the energy sector on electricity generation, installed electricity generation capacity and transmission and distribution losses by using the panel regression model with fixed effects. The paper also aims at clarifying whether the impact of the energy sector reform on generation efficiency differs among countries according to their level of development and regional characteristics. Empirical econometric models are estimated and then analyzed to observe the effects of the energy market reforms on electricity generation and electricity transmission and distribution losses. Our hypothesis is that the energy sector reforms in the European Union and selected SEE countries have a significant impact on electricity generation and electricity transmission and distribution losses, but that these effects are statistically more significant in the EU-15 (old Member States) than in the EU-12 (new EU Member States) and selected SEE countries. We also analyze the interaction effects of individual steps of the reforms in the electricity sector on electricity generation and electricity transmission and distribution losses.

The paper is organized as follows. Section 2 gives an overview of the empirical findings on the economic effects of reforms conducted in the energy sector with special reference

to electricity. Section 3 describes the econometric methodology and presents the obtained empirical results. The final section contains the conclusions.

2. Empirical Findings on the Effects of Energy Sector Reforms

There are a number of papers dealing with the results of the reforms in developed countries. The number of those focusing on transition and developing economies is rather small. The existing empirical literature in this field has only partially addressed the performance and determinants of reforms. Broadly, the findings of this literature may be summarized in several fields:

Institutional determinants of reforms: Bacon and Besant-Jones (2001) tested two hypotheses about reform determinants for a sample of 115 developing countries for 1998. The first hypothesis was that there is a positive correlation between the country policy and institutions and the reform. The second was that country risk is negatively correlated with reform. According to their results, the coefficient on the policy indicator and the coefficient on the risk indicator had the expected signs and were significant. They also detected some regional effects, which suggest that the countries in Latin America and the Caribbean are more likely to reform then the countries in the Middle East and Africa which are more likely to take fewer reform steps. The main limitation of this study is that it represents a cross-section regression analysis of data only for 1998.

In his econometric study, Ruffin (2003) investigates the impact of the institutional determinants of competition, ownership and extent of reform in electricity sector restructuring using a cross-section OLS-regression analysis of a set of models with observations of up to 75 developed and developing countries. The countries that are included in the models are those that undertook electricity sector reforms during the 1990s. Competition, ownership and the extent of the reform represent dependent variables, while judicial independence, distributional conflict and economic ideology represent explanatory variables. According to the results of the study, the relation between judicial independence on one hand, and the competition level and ownership type on the other, is ambiguous. The effect is also sensitive to model specification. Moreover, the results show that market-oriented economic ideology has a significantly positive impact on competition and private ownership, while the distributional conflict is found to be significantly positive correlated with higher level of monopoly. This study found that all explanatory variables are positively correlated with the overall reform score.

Vlahinic-Dizdarevic and Jakovac (2011) investigate the importance of institutions and regulators in the process of conducting economic reforms in the electricity sector for 27 transition countries. They assess the impact of regulatory quality, government effectiveness and independence of the electricity regulator on the success of electricity reforms by using mediation analysis. Their findings show that the regulatory quality completely mediates the effects of government effectiveness on the success in implementing electricity reforms. These results confirm that the regulatory quality is a crucial condition for the success of electricity reforms in transition countries, where the openness of the market and the level of competitiveness is not sufficient. Therefore the role of the government should be much wider than just setting the independent regulator *per se* and it should include the creation of an effective and transparent regulatory quality

that would make the market more competitive and the spillover effects and technology diffusion more effective.

Effects of privatization: The effects of privatization have been investigated in many papers but their conclusions are ambiguous. Bortolotti et al. (1998) conclude that effective regulation is crucial to the success of privatization. They use data on the privatization of electricity generation in 38 countries (both developed and developing) between 1977 and 1997.

Using a panel dataset of 19 OECD countries for the period 1987-1996, Steiner (2001) tests the impact of regulatory environment, the degree of vertical integration and the degree of private ownership on electricity prices and efficiency. The four main variables in her panel data analysis are: electricity price per unit, industrial to residential electricity price ratio, generation capacity utilization ratio and generation reserve margin. The first two variables represent the competitive aspects of reform, while the second two examine the reform's cost efficiency. Some elements of the electricity sector reform are tested separately in this study: the introduction of a wholesale power pool, unbundling of transmission system operator, third party access to transmission grid and privatization. The results of the study show that privatization leads to higher electricity prices and industrial to residential electricity price ratio. Moreover, privatization has no significant impact on cost efficiency. According to Steiner, there is a significantly positive relationship between the utilization rate on one hand, and private ownership and unbundling of generation and transmission on the other. Steiner also concludes that privatization leads to higher operating efficiency and capital utilization in developed countries. Using a similar analysis, but over a longer period of time, 1987-1999, Hattori and Tsutsui (2003) test the impact of unbundling of transmission from generation, third party access, the existence of a wholesale market and privatization on electricity prices. They detect that privatization leads to lower electricity prices for industrial consumers.

Using a fixed effects panel data model for 25 developing countries covering the period 1985-2001, Zhang, Parker and Kirkpatrick (2002) investigate the effects of privatization, competition and regulation reforms on electricity generation. They also test combined effects of regulation and competition and effects of regulation and privatization on electricity generation. The results of the study show that privatization *per se* is not associated with higher operating efficiency in terms of labor productivity. However, privatization leads to better capacity utilization. When there is a supportive independent regulatory authority in place, privatization will lead to higher output and increased capacity. The effects of privatization on electricity prices are insignificant.

New research by Zhang, Parker and Kirkpatrick (2008) about the effects of privatization, regulation and competition on efficiency in electricity generation activity, conducted on a sample of 36 transition and developing countries, came to similar conclusions. According to their results, regulatory reforms on their own are not sufficient to increase electricity generation. Moreover, if they are not conducted at the same time as other reforms, primarily unbundling and market liberalization, they can even worsen the performances of electricity generation companies. Therefore, regulatory quality is important, but has to be accompanied by other reforms. Furthermore, it demands independence and transparency of the regulatory body. They proved that competition and not privatization is a crucial element for efficiency improvement in the sector having a significant monopolistic/oligopolistic market structure. The data also shows that privatization is

helpful only when it is followed by a quality regulation framework and existence of an independent regulator. Their main conclusion is that privatization and regulation on their own do not lead to improvements in economic performances, even though there are some positive interactive effects. However, introducing competition is very efficient in stimulating improvements of economic performances.
Using a panel data for the EU-15 countries over the period 1978-2005, Florio et al. (2007) investigate the impact of electricity market reform on household electricity prices. The three main electricity market reform variables included in the model are: public ownership, vertical integration and entry. According to their results, entry and vertical integration do not seem to lower electricity prices, while the negative sign on public ownership indicates that more public ownership leads to lower electricity prices. They found that none of the electricity market reform indicators are individually significant. They rejected the widespread belief that public ownership leads to lower production efficiency. The results of the study show that privatization is not associated with lower electricity prices. In addition privatization does not lead to greater consumer satisfaction. They also find that some specific features in each country have a great impact on the course of the reform process.

Effects of competition and market liberalization have been the research interest in many papers. According to Zhang et al. (2002), competition leads to higher output, capacity and labor productivity in developing countries. They also found that competition has no statistically significant impact on electricity price ratio between industrial and residential consumers in developing countries. Steiner (2001) found that unbundling of generation and transmission in developed countries results in higher capacity utilization rates and lower reserve margins. Moreover, according to her study, unbundling does not lead to lower electricity prices but is positively correlated with cost-reflective pricing. Introduction of a wholesale power pool is associated with significantly lower electricity prices. Hattori and Tsutsui (2003) found that 'legal unbundling' leads to higher electricity prices, and that the introduction of wholesale power pool is associated with higher electricity prices.
Using a sample of EU-15 countries and a large number of simple regressions, Ernst & Young (2006) prepared a report for the UK's Department of Trade and Industry (DTI). They found that liberalization lowers electricity prices, costs and price-cost margins, provides a reliable and secure supply, but it also increases price volatility and even inhibits investment.

Thomas (2006) rejects the widespread beliefs that energy market reforms and liberalization in the European Union result in lower electricity prices for consumers. According to Thomas, price reductions occurred mostly in the period 1995-2000 before liberalization was effective in most of the EU countries. These price reductions were mostly the result of fossil fuel price movements, relatively low costs, changes in regulatory practices and technological innovations. After 2000, electricity prices have risen sharply both for residential and industrial consumers in the European Union. Furthermore, he suggests that the EU reform model’s real test is whether it can deliver timely investment to meet the emerging investment gap following the elimination of short run inefficiency and initially high reserve margins (Pollitt 2007).

Using a panel data for 83 countries covering the period 1985-2002, Nagayama (2007) tries to answer if and how individual reforms steps impact electricity prices for countries in Eastern Europe, the former Soviet Union and Latin America. The variables used in this study are: establishment of a regulatory agency, entry of independent power producers (IPP), introduction of a wholesale spot market and unbundling of generation and transmission. These individual reform steps have a variety of impacts on electricity prices. The research findings suggest that the introduction of a wholesale spot market and unbundling of generation and transmission do not lead to a reduction in electricity prices. Contrary to their expectations, these two individual reforms steps resulted in an increase of electricity prices. In addition, Nagayama found that the introduction of foreign independent power producers (IPP), competition in electricity retail markets and privatization have led to a reduction in electricity prices in some, but not in all of the regions. In his second paper, Nagayama (2009) wants to clarify whether the effects of energy sector reforms are systematically different among various country groups in relation to level of development and region. Nagayama observed the impact of electricity prices on the implementation of a liberalization model. In this study, a panel data from 78 countries in four regions is used for the period 1985-2003. The four regions include: developed countries, Latin America, Asian developing countries, Eastern Europe and the former Soviet Union. According to research findings, higher electricity prices have a significant impact on government decision to adopt liberalization models. The research findings suggest that the development of liberalization models in the electricity sector is not necessarily associated with lower electricity prices. Quite on the contrary, electricity prices have risen in every market model.

Effects of regulation have also been tested in order to determine the role of regulation on efficiency and prices. In developing and developed countries, independent regulation alone does not lead to higher productive efficiency (Zhang et al., 2002; Steiner, 2001) and, according to Zhang et al. (2002), it does not lead to higher electricity prices for consumers in developing countries. Vlahinic-Dizdarevic and Jakovac (2011) test the role of regulation on electricity reform success in 27 transition countries and find that defining the optimal regulatory framework and the regulatory quality is the key determinant of successful implementation of electricity sector reforms in transitional countries. They conclude that the establishment of a regulatory body *per se* is important but not sufficient for conducting successful reforms unless it is followed by the whole institutional quality. In this process, it is important to establish a regulatory body whose activity is independent from the government as well from the regulated industry. Siniscalco et al. (2001) wanted to clarify if regulation has a positive impact on privatization. The results of the study show that regulation has a positive impact on privatization.

An effective regulatory system is crucial for both investor confidence and consumer protection. A well-designed regulatory system should protect consumers from monopoly abuse and provide investors with protection from arbitrary political action. In addition, one of the main aims of a well-designed regulatory system is to provide investors with incentives to promote efficient operation and investments (Laffont and Tirole 1993). A regulatory system that is not well-designed can negatively affect a firm's input and output decisions and depress productivity (Averch and Johnson, 1962). Under risky regulatory conditions, private operators will be unwilling to invest and will produce less (Gupta and Sravat 1998; Holborn 2001). At the same time, clearly stated regulatory rules within a

well-defined regulatory framework can be expected to reduce 'regulatory risk' and provide incentives for private investment which is the main objective when independent regulatory bodies are established (Zhang et al., 2008). Therefore, a carefully designed regulation can be seen as a key component of a successful process of electricity reforms (Zhang et al., 2008).

Although the attitude of economic theory towards a positive impact of regulatory quality on the success of the electricity sector is clear, there are only a few empirical studies dealing with this issue and they are mainly focused on the efficiency of electricity generation, and not the sector as a whole. The lack of empirical, quantitative research of this issue is mostly the result of difficulties in quantifying regulatory quality parameters.

The most interesting study in the context of this research is the one by Erdogdu (2011). He investigates the impact of electricity sector reforms on its efficiency. The main goal of conducted reforms in the electricity sector was to increase the efficiency of the electricity sector as a whole. In this study, empirical econometric models are used for 92 developed and developing countries for the period 1982-2008. According to Erdogdu, it is almost impossible to observe the real impact of energy market reforms on efficiency without separating the effects of market reform from country specific features. The research findings suggest that the impact of the reforms on the electricity industry's performance is statistically significant but limited. The results imply that, after controlling for country-specific variables, the implementation of liberal market models in electricity industries slightly increases efficiency in the electricity sector. Besides, Erdogdu detects a positive relationship between the reform process and the percentage share of network (transmission and distribution) losses in total electricity supplied, meaning that as countries take more reform steps, the network losses, as a segment of electricity generated, tend to increase. Moreover, the study puts forward that the income level and other country specific features are more important determinants of industry efficiency than the reform process itself.

According to Pollitt (2007), in developing and transition economies, the focus of electricity reforms is not on short run efficiency improvement and price reduction. Electricity sector reforms may lead to significantly higher electricity prices, in order to ensure cost recovery, privatization may be a part of an overall move to stimulate electricity market and countries may, for the first time, be introducing effective and transparent independent regulation (Pollitt, 2007).

Jamasb et al. (2004) analyzed a large number of studies looking at electricity market reforms in developing countries. These studies cover a wider range of variables than those tested in the EU-focused studies and addresse additional issues such as the role of wider institutional arrangements (outside the electricity sector), energy resource endowments (whether self-sufficiency encourages reform), the impact of reform on investments and energy losses and the role of privatization and independent regulation (Pollitt, 2007).

Jamasb et al. (2004) summarize the econometric evidence contained in Wolak (1997), Zellner and Henisz (2000), Bacon and Besant-Jones (2001), Drillisch and Reichmann (1998), Holborn (2001), Siniscalo et al. (2001), Ruffin (2003), Bergara et al. (1997) and Zhang et al. (2002). (see Pollitt, 2007). According to Pollitt (2007), their main conclusions are:

1. Political and judicial institutions and energy resource endowments matter for progress with reform.
2. Privatization improves efficiency if accompanied by independent regulation. Competition improves efficiency in generation, but independent regulator alone is not significant for efficiency.

3. Privatization has no significant effect on prices; competition has a mixed effect, while regulation has no significant price effect.

4. Private investment is stimulated by the strength of property rights protection and the presence of independent regulation.
5. Vertical integration reduces the amount and value of privatization.
It should be noted that there has been limited cross-testing of most of the hypotheses across the studies, so further analysis is necessary to increase the reliability of the results. According to Jamasb et al. (2005), there is reason to question the robustness of some of the empirical findings as the comparability of the studies is constrained by variations in data and model specifications. It is hard to get a consistent picture of reform due to obstacles in comparability between different studies that use different data and methods. Even where there is a rather high degree of comparability, sensitivity of the findings to the choice and definition of variables and model specification, casts considerable uncertainty over the policy relevance of the existing body of knowledge.

3. The Data and the Model

The data used in our analysis is net electricity generation per capita (in GWh/million people), net installed electricity generation capacity per capita (in GWh/million people), net electricity generation per employee - (in GWh/million people) and electricity transmission and distribution losses (% of output) as dependent variables.
Erdogdu (2011) developed and presented the 'electricity market reform score' variable covering all the key elements of reforms in the electricity sector. In our research, we also use the same variable, but for a different group of countries. The explanatory (independent) variable is the 'electricity market reform' variable. It takes on the values from 0 to 8, depending on the number of reform steps taken in each country and each year. In order to build this variable, we have created 8 dummy variables for each of the reform steps. These are: (1) regulated third-party grid access, (2) corporatization of state-owned enterprises, (3) law for electricity sector liberalization, (4) introduction of unbundling, (5) establishment of an electricity market regulator, (6) introduction of privatization, (7) establishment of a wholesale electricity market and (8) choice of supplier. Then, we calculated the total number of reform steps taken in each country and each year to construct our reform score variable (see Erdogdu, 2011). The dummy variables for reform steps were created by the authors based on the collected and cross-checked data from various international and national sources.
We also tested the possible interactional effects of individual reform steps in the electricity sector on electricity generation and electricity transmission and distribution

losses. The following interactional variables were included in the model: (1) privatization and regulatory agency, (2). privatization and unbundling and (3) regulatory agency and unbundling.

The GDP per capita variable is used as a control variable and it represents a part of the country's specific features that may have an influence on the efficiency level in the electricity industry.

Tables 1 and 2 present the descriptive statistics and normality test for level and first differenced variables.

Table 1: Descriptive statistics of the variables in Model 1 (for EU-15)

Variables	Mean	Standard Deviation	Minimum	Maximum	Number of Observations
Dependent Variables					
Net electricity generation per capita	7.091135	.6910852	5.328518	9.592696	240
Net installed generation capacity per capita	1.938428	.1784281	1.444962	2.553249	240
Net electricity generation per employee in electricity sector	4.037382	.826799	.7015252	6.537857	240
Share of transmission and distribution electricity losses in output (%)	6.572456	3.008035	-2.571129	35.34674	240
Explanatory Variables					
Electricity market reform score	5.379167	2.631033	-.0583333	9.129167	240
Privatization and Regulator	.4791667	.3937934	-.3958333	1.166667	240
Privatization and Unbundling	.4625	.4010316	-.4125	1.15	240
Unbundling and Regulator	.6458333	.4419787	-.2291667	1.270833	240
GDP per capita	10.30838	.2829249	9.696869	10.87589	240

Source: Authors

Table 2: Descriptive statistics of the variables in Model 1 (for EU-12 and selected SEE countries)

Variables	Mean	Standard Deviation	Minimum	Maximum	Number of Observations
Dependent Variables					
Net electricity generation per capita	4.139673	.464603	2.817977	6.459713	208
Net installed generation capacity per capita	1.044113	.1692366	.5099791	1.892792	208
Net electricity generation per employee in electricity sector	1.296591	.3086592	.1557117	2.448997	208
Share of transmission and distribution electricity losses in output (%)	12.88576	5.057353	-8.358887	53.0912	208
Explanatory Variables					
Electricity market reform score	4.230769	2.201651	-1.615385	7.615385	208
Privatization and Regulator	.3605769	.3437611	-.5625	1.206731	208
Privatization and Unbundling	.3125	.3806935	-.3798077	1.158654	208
Unbundling and Regulator	.5240385	.4471305	-.2451923	1.139423	208
Control Variables					
GDP per capita	8.78551	.4746093	7.880023	9.742519	208

Source: Authors

The dataset covered in the analysis includes a sample of all EU Member States in which the electricity market reform process has been initiated. The economic effects of the electricity sector reforms on electricity generation and electricity transmission and distribution losses are analyzed for two groups of countries: the EU-15 (old EU Member States) and the EU-12 (new EU Member States) and selected Southeast European countries.

The data set for the EU-15 countries is based on a panel of the following 15 countries: Belgium, Denmark, Germany, Ireland, Spain, France, Italy, Luxembourg, Netherlands, Austria, Portugal, Finland, Sweden, Greece and United Kingdom. The EU-12 countries include: the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia, Slovakia, Romania and Bulgaria. The selected SEE countries included in the model are: Croatia, Bosnia and Herzegovina, FYR Macedonia and Albania. Due to the lack of data for the period 1998-2005, Serbia and Montenegro are not included (Montenegro became independent from Serbia in 2006). The data set for the EU-12 and selected SEE is based on a panel of 16 countries. In total our data set is based on a panel of 31 countries.

The time period used in the analysis is 1995 – 2010 for the EU-15 countries and 1998 – 2010, due to the unavailability of data, for the EU-12 and selected SEE countries.

We are aware that the analysis would be far more robust if a longer time span was available, especially for Southeast European countries, but this was impossible due to the lack of the data on electricity sector reforms. Generally, data availability shapes the content and manner of addressing research questions. Another common difficulty is how to represent qualitative aspects of reform such as institutional factors or market structure characteristics. Since these aspects are difficult to define and measure directly and objectively, a common approach has been to use proxies in the form of indices and categorical variables (Jamasb et al., 2005).

The methodology used in our research is based on panel data. It is necessary to emphasize some common characteristics of panel data. According to Gujarati (2004), panel data analysis eliminates the occurrence of problems such as heterogeneity and collinearity among variables; it increases the number of freedom levels and results in better explanation of used variables.

In this study the panel regression model with fixed effects was used. The fixed effects model is a common choice among scientists in cases when the model is evaluated based on the data which are not randomly chosen and where there is a high probability that each country has certain specific effects in correlation with regressors. The panel regression model with fixed effects produces consistent estimates. As we are dealing with different country samples (developed and developing countries) and bigger time series, country and time effects should be included in the model. They should be included in form of a fixed effects model when the focus is set on specific set of countries. A panel regression model with random effects is used when individual countries are chosen from a larger population (Jamasb et al. 2005).

4. Empirical Results and Discussion

The research results for the EU-15 are presented in Table 3.

Table 3: The impact of energy sector reforms on electricity generation and electricity transmission and distribution losses in the EU-15

Dependent variables	Net electricity generation per capita	Net installed electricity generation capacity per capita	Net electricity generation per employee in the electricity sector	Electric power transmission and distribution losses (% of output)

Explanatory variables				
Electricity market reform variable	0.098 (2.72)***	0.029 (3.91)***	0.169 (4.75)***	-0.28 (-1.67)*
Privatization and Regulator	0.496 (2.17)***	0.102 (2.18)***	0.049 (0.22)	-4.65 (-4.36)***
Privatization and Unbundling	-0.374 (-1.58)	-0.092 (-1.90)*	-0.036 (-0.15)	3.64 (3.29)***
Unbundling and Regulator	-0.176 (-0.88)	-0.08 (-1.96)*	-0.29 (-1.48)	1.652 (1.77)*
GDP per capita	0.58 (2.86)***	0.329 (7.94)***	1.080 (5.43)***	-2.094 (-2.22)**
Constant	0.671 (0.33)	-1.568 (-3.80)***	-7.826 (-3.96)***	29.156 (3.10)***
Number of Observations	240	240	240	240
R2	0.28	0.54	0.51	0.17

Note: Coefficient is significant at the ***1% level, **5% level, *10% level
Source: Authors' calculations

The research results show that energy market reforms in the EU-15 (electricity market reform variable) have a significantly positive impact on net electricity generation per capita, net installed electricity generation capacity per capita and net electricity generation per employee in the electricity sector. Moreover, energy market reforms in the EU-15 have a significant impact on the reduction of electricity transmission and distribution losses.

The interaction variable 'privatization and regulator' has a significantly positive impact on net electricity generation per capita, net installed electricity generation capacity per capita as well as on the reduction of transmission and distribution losses.

The interaction variable 'privatization and unbundling' has a significantly negative impact on net installed electricity generation capacity per capita and a significant impact on the increase of transmission and distribution losses.

The interaction variable 'unbundling and regulator' has a significantly negative impact on net installed electricity generation capacity per capita and a significant impact on the increase of transmission and distribution losses.

In line with our expectations, GDP per capita has a significantly positive impact on net electricity generation per capita, net installed electricity generation capacity per capita and net electricity generation per employee in the electricity sector. Moreover, GDP per capita has a significant impact on the reduction of electricity transmission and distribution losses.

Table 4 presents the empirical results for the EU-12 and selected Southeast European countries.

Table 4: The impact of energy sector reforms on electricity generation and electricity transmission and distribution losses in the EU-12 and selected Southeast European countries

Dependent variables	Net electricity generation per capita	Net installed electricity generation capacity per capita	Net electricity generation per employee in the electricity sector	Electric power transmission and distribution losses (% of output)
Explanatory variables				
Electricity market reform variable	0.119 (3.26)***	0.058 (3.89)***	0.091 (4.35)***	0.376 (0.80)
Privatization and Regulator	0.016 (0.10)	-0.115 (-1.67)*	-0.115 (-1.19)	-1.043 (-0.49)
Privatization and Unbundling	-0.236 (-1.45)	-0.027 (-0.41)	0.075 (0.79)	1.056 (0.51)
Unbundling and Regulator	0.031 (0.24)	-0.150 (-2.77)***	-0.264 (-3.48)***	-1.442 (-0.86)
GDP per capita	0.091 (0.65)	-0.013 (-0.23)	0.248 (3.03)***	-2.958 (-1.63)
Constant	2.880 (2.54)***	1.041 (2.22)**	-1.115 (-1.70)*	38.085 (2.62)***
Number of Observations	240	240	240	240
R2	0.315	0.121	0.481	0.054

Note: Coefficient is significant at the ***1% level, **5% level, *10% level.
Source: Authors' calculation

The research results show that energy sector reforms in the EU-12 and other selected countries in Southeast Europe (electricity market reform variable) have a significantly positive impact on net electricity generation per capita, net installed electricity generation capacity per capita and net electricity generation per employee in the electricity sector. Unlike in the EU-15 countries, energy sector reforms in the EU-12 and selected Southeast European countries have no significant impact on electricity transmission and distribution losses. This may be the consequence of the inadequate level of investment in electricity transmission and distribution network, inadequate development of transmission interconnection capacity, low level of network capacity maintenance and/or outdated technology. The problems in transition countries were numerous: economic losses due to financial indiscipline and poor collection of bills as well as technical losses as a consequence of old technology, especially in transmission networks.

The interaction variable 'privatization and regulator' has a significantly negative impact on net installed electricity generation capacity per capita.

The interaction variable 'privatization and unbundling' has no significant impact on any dependent variable.

The interaction variable 'unbundling and regulator' has a significantly negative impact on net installed electricity generation capacity per capita and net electricity generation per employee in the electricity sector.
GDP per capita, as a control variable, has a significantly positive impact on net electricity generation per employee in the electricity sector.
The obtained results show that the unbundling of electricity segments in interaction with privatization and the regulatory agency is not associated with the increase in electricity generation efficiency. On the other hand, the unbundling of electricity activities in interaction with privatization and the regulatory agency may have a negative impact on efficiency indicators in electricity generation. In the EU-15, the unbundling in interaction with privatization and the regulatory agency increase the level of electricity transmission and distribution losses.
Several factors are in favor of the integration of electricity segments. First, a common ownership of electricity activities enables minimization of costs far more than when these are unbundled. Secondly, vertically integrated generation and transmission simplify the link between the investments in electricity generation capacities and the return on invested assets. It is worth mentioning that the investments in the electricity sector are specific, as there is a high level of uncertainty of asset return. This is the case with narrowly specialized investments where there is almost no possibility of changing their purpose. Consequently, the investors are interested to invest only if their investment is secured, either in form of a long-term delivery arrangement or unique company model. In the case of electricity generation and distribution there are two additional factors in favor of integration: investment planning and urgent interventions in electricity supply for consumers.
Competition and privatization are expected to lead to external and internal efficiency. However, unbundling of the system tends to increase transaction costs and loss of economies of coordination. The net effect is uncertain in the absence of independent regulatory oversight. The effectiveness of competition and incentive regulation will determine whether the benefits of the reform will exceed the higher transaction costs in order to produce net performance improvements (Jamasb et al., 2005). The reason lies in the fact that economic and political institutions which are necessary for a proper functioning of the regulatory bodies are still underdeveloped in most transition countries. Regulatory agencies are also faced with the lack of qualified human, administrative and know-how resources. Their complete independence is questionable as the government still has a formal or informal impact on them, particularly in those activities that are related to electricity prices. Another issue is the informal influence of the regulated industry, in regards to the high concentration of staff coming from the electricity industry, which put regulators in a bad position. Therefore, the regulation can lose its initial purpose and instead of protecting the consumers, it starts protecting the regulated industry (Vlahinić-Dizdarević 2011). According to Kirkpatrick and Parker (2004), institutional capacities, including the capacity for building the optimal regulatory regime, are the biggest problems the transition countries are dealing with at the moment.
The process of adjustment to new conditions has been far more difficult for transition countries as their electricity systems entered the reform process with a significantly negative heritage. Transition countries did not start with electricity sector reforms from an equal starting point as the developed countries in the European Union and therefore

their worse reform results should be analyzed in a different economic, institutional and political environment.

5. Conclusion

Since the findings on some issues regarding the energy sector reforms have been limited and inconclusive, some important areas are yet to be addressed. Therefore the goal of this research is to understand better the reform process by providing solid economic evidence on energy sector reform results on electricity generation in European framework. We tested the hypothesis that energy sector reforms in the European Union and selected SEE countries have a significant impact on electricity generation and electricity transmission and distribution losses, but that these effects are statistically more significant in the EU-15 (old Member States) than in the EU-12 (new EU Member States) and selected SEE countries.

The data used in our analysis is net electricity generation per capita, net installed electricity generation capacity per capita, net electricity generation per employee in electricity sector and electricity transmission and distribution losses (% of output) as dependent variables. The explanatory (independent) variable is the 'electricity market reform score' variable developed by Erdogdu (2011).

The dataset covered in the analysis includes a sample of all EU Member States in which the electricity market reform process has been initiated. The economic effects of the electricity sector reforms on electricity generation and electricity transmission and distribution losses are analyzed for two groups of countries: the EU-15 (old EU Member States) and the EU-12 (new EU Member States) and selected Southeast European countries. The selected SEE countries included in the model are: Croatia, Bosnia and Herzegovina, FYR Macedonia and Albania. Due to the lack of data for the period 1998-2005, Serbia and Montenegro are not included. The time period used in the analysis is 1995 – 2010 for the EU-15 countries and 1998 – 2010, due to the unavailability of data, for the EU-12 and selected SEE countries. In our analysis, we have used the panel regression model with fixed effects.

The research results show that unlike in the EU-15 countries, energy sector reforms in the EU-12 and selected Southeast European countries have no significant impact on electricity transmission and distribution losses. When we applied the interaction variables, we found the results rather unexpected since the unbundling of electricity activities in interaction with privatization and regulatory agencies have a negative impact on efficiency indicators in electricity generation and even increase transmission and distribution losses. This is due to the fact that common ownership enables minimization of costs far more than when the electricity segments in a company are unbundled. Secondly, vertically integrated generation and transmission simplify the link between the investments in electricity generation capacities and the return on invested assets. This is important because there is a high level of uncertainty of asset return and the investors are interested in investment only if their investment is secured, either in form of a long-term delivery arrangement or unique company model. In the case of electricity generation and distribution there are two additional factors in favor of integration: investment planning and urgent interventions in electricity supply for consumers.

The research results also show that there are important difference between the old EU Member states on one hand and the new EU Member States and Southeast European countries on the other. The process of adjustment and energy reforms has been far more difficult for transition countries since their electricity systems entered the reform processes with a significantly negative heritage. The transition countries did not start electricity sector reforms from an equal starting point as the developed countries in the European Union and therefore their worse reform results should be analyzed in a different economic, institutional and political environment.

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