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The impact of power market reforms on electricity price-cost margins and cross-subsidy levels: a cross country panel data analysis

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Abstract

One of the main expectations from power market reform has been a reduction in price-cost margins and cross-subsidy levels between industrial and residential consumers. This paper focuses on this issue by looking at the impact of the electricity industry reforms on residential and industrial electricity price-cost margins *and* their effect on cross-subsidy levels between consumer groups. Using panel data for 63 developed and developing countries covering the period 1982–2009, empirical models are developed and analyzed. The research findings suggest that there isn't a uniform pattern for the impact of reform process as a whole on price-cost margins and cross-subsidy levels. Each individual reform step has different impact on price-cost margins and cross subsidy levels for each consumer and country group. Our

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findings imply that reform steps have different impacts in different countries, which supports the idea that reform prescription for a specific country cannot easily be transferred to another one. So, transferring the formal and economic structure of a successful power market in a developed country to developing countries is not a sufficient condition for good economic performance of the electricity industries in developing countries. Furthermore, the study suggests that power consumption, income level and country specific features constitute other important determinants of electricity price-cost margins and cross-subsidy levels.

Keywords: *Models with Panel Data; Power Market Reform; Electricity prices*

1. Introduction

Starting from the early 1980s, a number of political, financial and technical factors converged and started to undermine the logic that electricity industry should be handled via a vertically integrated (and usually state-owned) monopoly (Gratwick and Eberhard, 2008). Among these factors, there were ideological reasons[1], development of gas-fired combined cycle gas turbines[2] (CCGTs), improvement in information and communication technologies, questions about the efficiency of vertically integrated utilities (whether publicly owned *or* regulated by public) and poor performance of existing utilities especially in developing countries. However, electricity reform in most developing countries was a fundamentally different undertaking from the reform in developed countries in terms of motivations, sector conditions, and institutional context. In developed countries, the main targets of the reform has been the improvement in the economic efficiency of the sector; encouragement of inter-regional (or cross border) trade, transferring investment risks to the private sector and offering customer choice. Other subsidiary motives include the demonstration effects of the pioneering reforms of the power sectors in the UK and Norway in the early 1990s; and rapid changes in technology especially in the generation of electricity that made new industrial structures

[1] In the United Kingdom, for example, privatization of state owned electricity utility reinforced the ideology of the Thatcher government and its interest in reducing the costs of domestic coal subsidies. Similar ideological and political explanations can be found from Norway to New Zealand. (Hogan, W.W., 2002. Electricity Market Restructuring: Reforms of Reforms. J Regul Econ 21, 103-132.)

[2] The advent of highly efficient CCGTs made it possible to build small units in relatively short time with little risk, which eliminated the significant barriers that had previously existed to entry in power generation.

possible; the desire to overcome what might be called sub-optimal regulation; and the policy objective to eliminate tendency to over-invest (so called “gold-plating”). On the other hand, in developing countries, motivation for reform includes the poor performance of state-run electricity operators in terms of high costs, inadequate expansion of access to electricity services and unreliable supply; the inability of the public sector to meet the investment and maintenance costs of the electricity industry associated with the increasing demands for power resulting from economic development; the need to remove the burden of price subsidies (so as to release resources for other areas of public expenditure), low service quality, low collection rates, high network losses; the desire to raise immediate revenue for the government through the sale of state assets; the policy to attract foreign direct investment in power sector; and encouragement of reform by international financial organizations and donor agencies such as the IMF and World Bank (Zhang et al., 2008). However, in all reforming countries (whether developed *or* developing), reforms in power markets have aimed at realizing two common objectives: (i) reductions in price-cost margins, and (ii) improvements in service quality. In this paper, we focus on the former aim while investigation of the latter objective is left to future papers.

As we mentioned above, one of the principal expectations from power sector reform is the reduction in electricity price-cost margins to be achieved mainly by increase in efficiency in the industry and realization of cost-reflective prices. It is argued that, even in the short run, reform process introduces competition, which in turn encourages economic units with the lowest costs to operate in the market while discouraging those that cannot profitably participate in the market at the prevailing market prices. Besides, over the longer term, markets present better incentives for new entrants; and new entrants with more efficient technologies put additional downward pressure on prices. Together with cost-reflective prices, it is expected that the introduction of reforms in the electricity markets leads to lower electricity price-cost margins. This paper tries to find out whether power market reforms realize this expectation, or in other words, whether the reforms have moved prices towards long-run marginal costs (LRMC).

The paper also aims at clarifying whether the effects of power sector reform on electricity price-cost margins are different between industrial and residential consumers and between developed and developing countries. Empirical econometric models are estimated and analyzed to observe the impact of electricity market reform process on price-cost margins. The econometric models are designed using panel data from 63 countries[3]. The dataset covers the period from 1982 to 2009.

We try to answer following research questions: (i) what is the impact of electricity market reforms on electricity price-cost margins? (ii) does liberalization result in more cost reflective prices by reducing cross-subsidies between consumer groups? (iii) what are the other factors that influence electricity price-cost margins and cross-subsidy levels and how much are they influential relative to reform process?

In point of fact, fluctuations in fossil fuel prices constitute one of the most important determinants of final electricity prices and, therefore, price-cost margins. However, to our surprise, this variable has been ignored so far in almost all cross country econometric studies trying to explain the impact of reforms on electricity prices (see Ernst & Young (2006), Fiorio et al. (2007), Nagayama (2007, 2009), Steiner (2001) and Thomas (2006)). Since fuel costs are probably the most important component of end user prices, any study excluding this variable destines to fall short. In view of the fact that our study is the first to take into account variations in fuel costs in the explanation of impact of reforms, it not only is an important contribution to the existing literature but also fills an important gap in this area.

The paper proceeds as follows. Next section provides a literature review on the impact of electricity sector reform process on electricity prices. Section 3 summarizes the methodological framework. Section 4 describes data. Following section presents empirical analysis and discusses the results. Section 6 mentions potential limitations of the study. The last section concludes after considering possible policy implications of the results.

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[3] ***Developed countries (32):*** Australia, Austria, Belgium, Canada, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovak Republic, Spain, Sweden, Switzerland, Taiwan (Chinese Taipei), Trinidad and Tobago, United Kingdom, United States.

Developing countries in America (21): Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, Venezuela.

Other developing countries (10): China, India, Indonesia, Kazakhstan, Poland, Romania, Russian Federation, South Africa, Thailand, Turkey.

2. Literature review

In this section, we review empirical literature on the impact of electricity sector reform process on electricity prices. There is an extensive volume of literature on electricity market reforms but most of it is in the form of opinion and discussion without any empirical analysis. In line with our objectives, we focus only on those studies which aim at revealing the relationship between power market reforms and electricity prices by analysing cross-country data or developing a logical framework to evaluate cross-country evidence.

Steiner (2001) carried out the first study focusing on the effect of electricity market reform on final electricity prices. She studied the effect of regulatory reforms on the retail prices for large industrial customers as well as the ratio of industrial price to residential price, using panel data for 19 OECD countries for the period 1986-1996. In her analysis, she used electricity price, ratio of industrial to residential electricity price, capacity utilization rate and reserve margin as variables. The study found that electricity market reforms generally induced a decline in the industrial price and an increase in the price differential between industrial customers and residential customers, indicating that industrial customers benefit more from the reform. She also found that unbundling is not associated with lower prices but is associated with a lower industrial to residential price ratio and higher capacity utilization rates and lower reserve margins. Hattori and Tsutsui (2004) also examined the impact of the regulatory reforms on prices in the electricity industry. Like Steiner (2001), they used panel data for 19 OECD countries but for the period 1987-1999. They found, first, that expanded retail access is likely to lower industrial price, while at the same time increasing the price differential between industrial and household customers. Additionally, they concluded that unbundling of generation did not necessarily lower the price and may have possibly resulted in higher prices. Like Steiner (2001), their estimation showed that the effect of unbundling on the level of industrial price is statistically insignificant. Besides, they found that introduction of a wholesale power market did not necessarily lower the price, and may indeed had resulted in a higher price. Their estimates showed, without exception, that establishing a wholesale power market resulted in statistically significantly higher prices and also increased the ratio of industrial price to household price, although not in a statistically significant manner.

Furthermore, they detected that a large share of private ownership lowers the industrial price but may not alter the price ratio between industrial and household customers.

Pollitt (2009) mentions two other empirical studies that examine the price impacts of reform by Ernst & Young (2006) and Thomas (2006). Ernst & Young (2006) prepared a report for the UK government's Department of Trade and Industry (DTI). In their study, they used a sample of EU-15 countries and tried to produce some policy suggestions for electricity and gas industries with a large number of simple regressions. As a result of their study, they concluded that liberalization lowers prices; liberalization lowers costs and price-cost margins; and liberalized markets increase price volatility. Thomas (2006) examined a number of reports including those of European Commission which look at (or comment on) electricity prices. Although these studies, he argued, suggest that reforms in the EU have been associated with lower prices for consumers, the evidence does not support these assertions. The price reductions, he continued, that have occurred in the past decade took place mostly in the period 1995-2000, before liberalization was effective in most of the European Union and since then, prices have risen steeply, in many cases wiping out the gains of the earlier period. For him, other factors, not properly accounted for, such as fossil fuel price movements, technological innovations and changes to regulatory practices were more likely to have led to the price reductions that occurred in the period 1995-2000 than reforms that had not then taken effect. He also underlined 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.

Fiorio et al. (2007) questioned the widespread beliefs that public ownership can be an impediment to other reforms and that it leads to production inefficiency. To test for this and the reform paradigm in general, they considered electricity prices and survey data on consumer satisfaction in the EU-15. Their empirical findings rejected the prediction that privatization leads to lower prices, or to increased consumer satisfaction. They also found that country specific features tend to have a high explanatory power, and the progress toward the reform paradigm is not systematically associated with lower prices and higher consumer satisfaction.

Other two studies on econometric modelling of electricity market reforms come from two papers by Nagayama (2007, 2009). Nagayama (2007) used panel data for 83 countries covering the period 1985-2002 to examine how each policy instrument of the reform measures influenced electricity prices for countries in Latin America, the former Soviet Union, and Eastern Europe. The study found that variables such as entry of independent power producers (IPP), unbundling of generation and transmission, establishment of a regulatory agency, and the introduction of a wholesale spot market have had a variety of impacts on electricity prices, some of which were not always consistent with expected results. The research findings suggested that neither unbundling nor introduction of a wholesale pool market on their own necessarily reduces the electricity prices. In fact, contrary to expectations, there was a tendency for the prices to rise. He argued, however, coexistent with an independent regulator, unbundling may work to reduce electricity prices. He found that privatization, the introduction of foreign IPP and retail competition lower electricity prices in some regions, but not in all regions. In his second paper, Nagayama (2009) aimed at clarifying whether the effects of power sector reforms should be different either across regions, or between developing and developed countries. He analyzed an empirical model to observe the impact of power prices on the selection of a liberalization model in the power sector. This was achieved by the use of ordered response, fixed effect and random effect models. An instrument variable technique was also used to estimate the impact of the liberalization model on the power price. These econometric models were designed using panel data from 78 countries in four regions (developed countries, Asian developing countries, the former Soviet Union and Eastern Europe, and Latin America) for the period from 1985 to 2003. The research findings suggested that higher electricity prices are one of the driving forces for governments to adopt liberalization models. However, the development of liberalization models in the power sector does not necessarily reduce electricity prices. In fact, contrary to expectations, the study found that there was a tendency for the prices to rise in every market model.

3. Methodological framework

It is almost impossible to observe the real impact of power market reforms on prices without separating the effects of market reform from variations in fuel costs and other country specific features. Therefore, instead of using prices directly in our analysis, we calculate electricity price-cost margins for each country and for each year and use this variable in our models as dependent variable. However, it is important to remember that what we refer as "price-cost margin" in this study is actually "electricity end use price - fuel cost margin"; it is ***not*** a measure of "economic profit"[4] and, therefore, ***not*** expected to be zero. Electricity price-cost margin in this study includes items such as capital costs, transmission and distribution costs, accounting profit of the electricity utilities and so on. Since fuel costs are usually external to electricity industry (that is, fuel prices are determined by international markets), they should be separated from final electricity prices to observe the real impact of reforms on electricity price trends. Therefore, we deduct fuel prices from final electricity prices. We take into account only coal and natural gas import costs in the calculation of fuel costs because the cost of all remaining inputs (like those for nuclear and renewable power plants) are so low that they can be ignored. Additionally, one of the most important reform targets has been removing cross-subsidies between consumer groups and making prices reflect the real cost of providing electricity. Therefore, apart from electricity prices, we also look at the impact of power market reforms on cross-subsidy levels.

We specify price-cost margins and cross-subsidy levels as a function of (i) electricity market reform indicators (dummy variables for individual reform steps and their cross-products), (ii) a set of controls (electricity consumption, transmission and distribution losses and income level), (iii) country-specific effects (these are assumed to be exogenous and to exist independently of reform process, but may explain a portion of the variation in electricity prices) and (iv) other unobserved variables that influence electricity price-cost margins and cross-subsidy levels. These variables are then used in panel regressions to assess their impact on price-cost margins and cross-subsidy levels. In panel regressions, the exploitation of both cross-country and time-series dimensions of the data allows for control of country-specific effects. Apart from reform process, price-cost margin and cross-subsidy level in a specific country and year are expected to be influenced by some other variables like electricity consumption, income level, transmission & distribution losses and so on. In our models, we include these variables in order to isolate the effect of the reforms on price-cost margins and cross-subsidy levels. Besides, prices for industrial consumers are usually supposed to be more

[4] Economic profit refers to the difference between the revenue received from the sale of an output and the opportunity cost of the inputs used. In calculating economic profit, opportunity costs are deducted from revenues earned. Therefore, at an optimum level, economic profits are expected to be zero.

cost-reflective than prices for households. Hence, in our analysis, we make a distinction between industrial and residential electricity prices.

We formulate regression equations as below to analyze the impact of electricity industry reforms on industrial and residential electricity price-cost margins and cross subsidy levels between consumer groups.

$$Y_{it} = \beta_1 + \sum_{j=2}^{k} \beta_j X_{jit} + \sum_{p=1}^{s} \gamma_p Z_{pi} + \delta t + \varepsilon_{it} \quad (1)$$

In the model, *i* and *t* represent unit of observation and time period, respectively. *j* and *p* are indices used to differentiate between observed and unobserved variables. X_{ji} and Z_{pi} represent observed and unobserved variables, respectively. X_{ji} includes both reform indicators and control variables. Y_{it} is dependent variable (that is, electricity price-cost margins and deviation from unit industrial/residential price ratio). ε_{it} is the disturbance term and *t* is time trend term. Because the Z_{pi} variables are unobserved, there is no means of obtaining information about the $\sum \gamma_p Z_{pi}$ component of the model. For convenience, we define a term α_i, known as the unobserved effect, representing the joint impact of the Z_{pi} variables on Y_{it}. So, our model may be rewritten as follows:

$$Y_{it} = \beta_1 + \sum_{j=2}^{k} \beta_j X_{jit} + \alpha_i + \delta t + \varepsilon_{it} \quad (2)$$

Now, the characterization of the α_i component is crucially important in the analysis. If control variables are so comprehensive that they capture all relevant characteristics of the individual, there will be no relevant unobserved characteristics. In that case, the α_i term may be dropped and pooled data regression (OLS) may be used to fit the model, treating all the observations for all time periods as a single sample. However, since we are not sure whether control variables in our models capture all relevant characteristics of the countries, we cannot directly carry out a pooled data regression of Y on X. If we were to do so, it would generate an omitted variable bias. Therefore we prefer to use either a Fixed Effects (FE) or Random Effects (RE) regression. In FE model, the country-specific effects (α_i) are assumed to be the fixed parameters to be estimated. In RE model, the country-specific effects (α_i) are treated as stochastic. The fixed effect model produces consistent estimates, while the estimates obtained from the random effect model will be more efficient. There are more than 90 countries in the world where a reform process has been initiated but data is available only for 63 countries.

That is, our sample is limited by data availability. Besides, electricity prices may or may not be country specific as in some regions there are regional electricity markets where prices are determined across countries. Therefore, we cannot be sure whether the observations in our model may be described as being a random sample from a given population; and cannot directly decide which regression specification (FE or RE) to use. It will be decided in the course of the analysis based on Hausman test.

In line with our research questions, the two main hypotheses we test in this study are given below:

Hypothesis 1. As countries introduce reform steps (that is, as the market moves further from monopoly and closer to competition), electricity price-cost margins tend to decrease.

Hypothesis 2. With reform process, the cross-subsidy between industrial and residential consumers declines.

Based on our hypotheses above, we expect a negative relationship between individual reform steps and electricity price-cost margins. Similarly, we anticipate a negative relationship between reform steps and absolute value of deviation from unit industrial/residential price ratio.

4. Overview of data

Our data set is based on a panel of 63 countries for a period beginning in 1982 and extending through 2009. Year 1982 is selected as the starting date for the study because at that time electricity market reform was initiated for the first time in Chile. The final date, 2009, represents the last year for which data are available at the time the research is conducted. The countries in our sample are determined by data availability, especially by data on electricity prices for residential and industrial consumers and fuel costs in electricity generation. Since our panel dataset includes data on 63 countries for 28 years, the total number of maximum observations is 1,764 (63x28). Because of the missing observations, our panel is unbalanced.

The variables used in the study are dummy variables representing individual reform steps and their cross-products, price-cost margin for industry and households, absolute value of deviation from unit (=1) industrial/residential price ratio, electricity consumption by industry and households, electricity losses and income level (GDP per capita). We also divided all countries in our dataset into three groups (developed countries, developing countries in America and other developing countries) based on classification made by World Bank (2010a) and included a dummy variable for each group of country into our dataset.

The dummy variables representing the existence of individual reform steps are as follows: (1) independent power producers (IPPs), (2) wholesale electricity market, (3) choice of supplier, (4) unbundling, (5) privatization, (6) electricity market regulator. In addition to these variables, we also include the cross-products of the last three variables into our analysis as we expect that combination of them may have different impact than when they exist alone. So, our additional three variables are (7) privatization and regulator, (8) privatization and unbundling, (9) unbundling and regulator. The dummy variables for reform steps are created using data collected and cross-checked from various international and national energy regulators' web sites[5].

Data on electricity prices are obtained from International Energy Agency (IEA, 2010c) and Latin-American Energy Organization (OLADE, 2010). The unit of observation is current US$/kWh. Electricity price data are available separately for residential and industrial users and cover 63 countries.

Fuel cost data are taken from IEA and consist of two set of data on natural gas import costs (USD/MBtu) and coal import costs (USD/tonne) (IEA, 2010a, b). For US, Japan and South Korea, we use LNG import costs as natural gas import cost data while pipeline import costs are used for the rest. Also, we utilized average EU natural gas pipeline import prices as a proxy for natural gas import costs in the countries for which the natural gas import cost data is not available. *Coking coal* is required for production of coke used in steel industries and *steam coal* is used in thermal power plants for steam production. Since we are concentrating on electricity generation costs in our study, we used steam coal import costs in our analysis. Coal data is missing for some countries in our sample too. We used average EU steam coal

[5] The full list of sources from which data are obtained can be found at IERN web site (http://www.iern.net).

import costs as a proxy for coal import cost for Norway, Switzerland and EU member or candidate countries for which data are missing. For other countries with missing observations, we used OECD averages. As we take into account the fact that energy markets (including natural gas and coal markets) have been internationalized in the last two decades, utilization of average EU or OECD import prices as a proxy for import costs in other countries seems to be justified.

Having collected data on end-user electricity prices and fuel import costs, we calculated price-cost margins as follows. First of all, we converted electricity prices into US$/MWh by multiplying prices in US$/kWh by 1,000. Then, we converted the data on fuel import costs into a common unit, USD/MBtu. In the conversion process, we used the equation 1 MBtu = 0.036 tonne of coal equivalent. After conversion, we weighted these two variables by ***both*** the output of electricity from natural gas and coal within each country and year ***and*** heat rate[6] of these two fuels. Data on electricity production from natural gas and coal are obtained from IEA (IEA, 2010d). For instance, if we assume that data for a specific country and a specific year are as follows, price-cost margin for industry in this country and year is calculated as 82.2 US$/MWh, as shown below.

- Electricity price for industry: 145 US$/MWh
- Natural gas import cost: 9 USD/MBtu
- Coal import cost: 5 USD/MBtu
- Electricity generation from natural gas: 175 TWh
- Electricity generation from coal: 125 TWh

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[6] The term “heat rate” refers to a power plant’s efficiency in converting fuel to electricity. Heat rate is expressed as the number of British thermal units (Btu) required generating a kilowatt hour (kWh) of electricity. Lower heat rates are associated with more efficient power generating plants. In the literature, **spark spread** refers to the theoretical gross income of a gas-fired power plant from selling a unit of electricity, having bought the fuel required to produce this unit of electricity. All other costs (operation and maintenance, capital and other financial costs) must be covered from the spark spread. The term **dark spread** refers to the similarly defined difference between cash streams (spread) for coal-fired power plants. In short; spark/dark spread is the difference between the wholesale price of electricity and the cost of the fuel used to generate it taking into account the heat rate of each fuel. In our study, however, we calculate price-cost margin as the difference between end-user (not wholesale) electricity prices and fuel costs. Actually, price-cost margin varies between plants using different fuels and may vary even between plants using the same fuels. However, for simplicity we assume a heat rate of 10,000 Btu/kWh for coal-fired plants and 8,000 Btu/kWh for gas-fired ones (For more details see US EIA, 2010. Average Operating Heat Rate for Selected Energy Sources. U.S. Energy Information Administration.).

- Heat rate for gas-fired plants: 8,000 Btu/kWh (= 8000/1000 Btu/MWh)
- Heat rate for coal-fired plants: 10,000 Btu/kWh (= 10000/1000 Btu/MWh)

$$145-\frac{9*(8000/1000)*175+5*(10000/1000)*125}{(175+125)}\approx 82.2$$

In 2007, on average, 42.3% of total electricity generation came from natural gas and coal in our sample countries (IEA, 2010d) and in 20 of them, gas and coal were responsible for more than 65% of all generation. Nuclear, hydro and other renewable sources accounted for most of the remaining generation. Since the fuel costs in nuclear power plants and renewable electricity generating facilities constitute a very limited portion of the total cost, we focus only on the fuel cost in natural gas or coal-fired power plants where fuel costs have the largest share in total cost. Figure 1 shows the changes in price-cost margins for industry and households during the last two decades in countries for which data are available.

In a situation where there is no cross-subsidy between industrial and residential consumers and ignoring disproportional distribution and transmission charges paid by different consumer groups, electricity prices for industry and households are expected to be almost the same and therefore industrial/residential price ratio turns to be very close to 1. However, due to cross-subsidies, industrial/residential price ratio deviates from its unit (that is, 1) value. In our study, we created absolute value of deviation from unit (=1) industrial/residential price ratio variable[7] to measure the size of the cross-subsidy between industrial and residential consumers. We do not attempt to distinguish between the directions of cross subsidy from industrial consumers to households and vice versa; therefore we use absolute values. We assume that any deviation from unit industrial/residential price ratio results in inefficiency in the industry.

Data on electricity consumption and transmission & distribution losses come from IEA (IEA, 2010e). Data on GDP per capita are obtained from World Bank (World Bank, 2010b). Table 1 shows descriptive statistics of the variables in our analysis.

[7] It is equal to the absolute value of [1 - (industrial prices / residential prices)].

Figure 1. Electricity end user price - fuel cost margins in 1987 and 2007

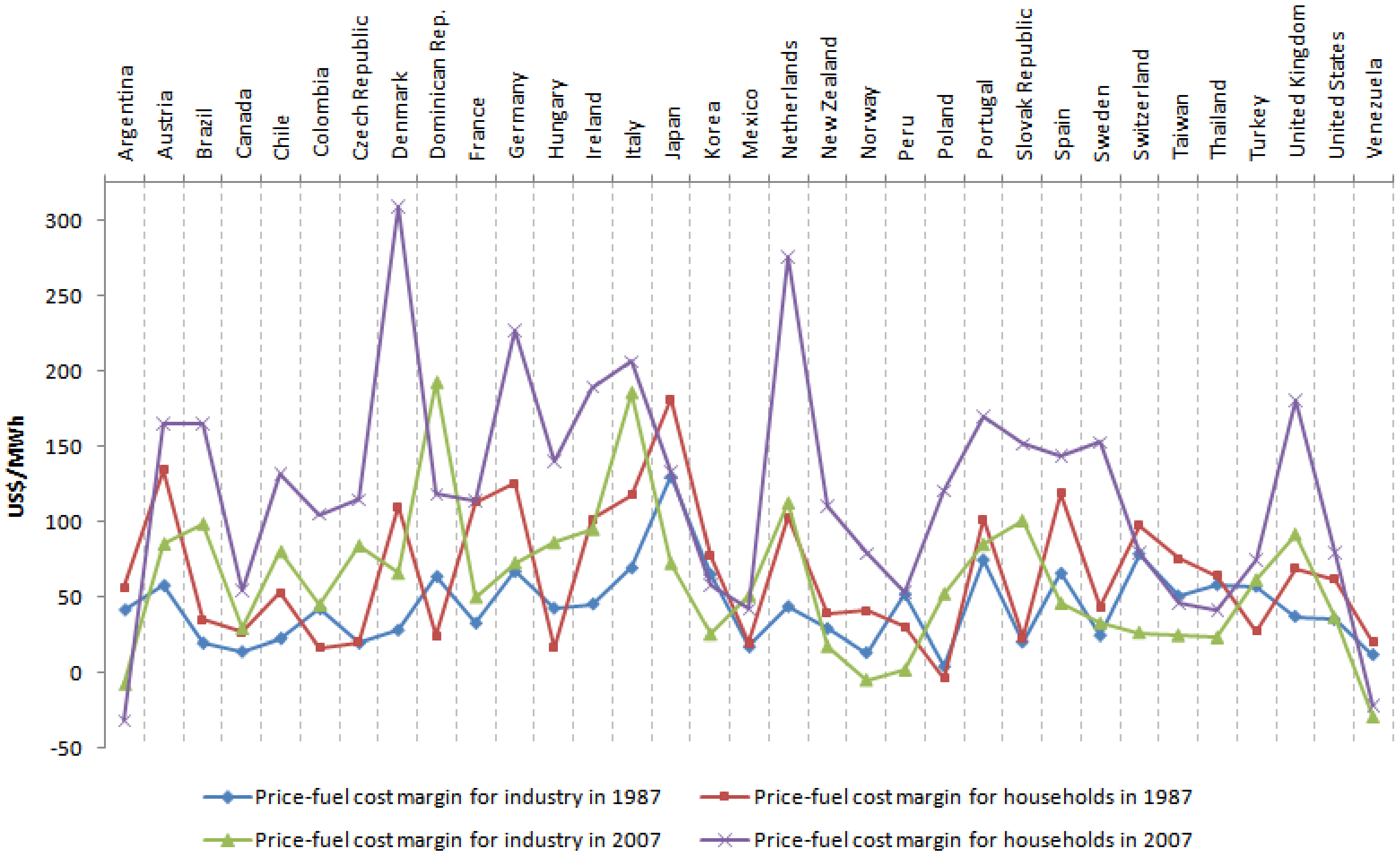

Table 1. Descriptive statistics of the variables in the model

Variables (Units)	**# of obs.**	**# of countries**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Price-cost margin for industry (US$/MWh)	1,127	54	40.90	28.12	-32.03	212.55
Price-cost margin for households (US$/MWh)	1,179	54	74.18	50.77	-33.13	344.40
Absolute value of deviation from unit industrial/residential price ratio (=1)	1,428	61	0.39	0.27	0	2.86
Electricity consumption by industry sector (GWh)	1,614	63	68,257	159,064	41	1,867,656
Electricity consumption by households (GWh)	1,614	63	43,490	137,925	0	1,392,241
Proportion of loses in total supply (%)	1,614	63	11.05	7.52	0	55.87
GDP per capita (current thousand US$)	1,650	63	11.81	13.61	0.20	109.90
Independent power producers (IPPs)	1,764	63	0.49	0.50	0	1
Wholesale electricity market	1,764	63	0.27	0.44	0	1
Choice of supplier	1,764	63	0.21	0.41	0	1
Unbundling	1,764	63	0.37	0.48	0	1
Privatization	1,764	63	0.35	0.48	0	1
Electricity market regulator	1,764	63	0.40	0.49	0	1
Privatization and regulator	1,764	63	0.29	0.45	0	1
Privatization and unbundling	1,764	63	0.29	0.45	0	1
Unbundling and regulator	1,764	63	0.33	0.47	0	1

5. Empirical analysis and discussion of the results

Throughout our analysis, we estimate three groups of models to explain electricity price-cost margins for industry & households and deviation from unit industrial/residential price ratio. Each group includes an overall model including all countries and other three sub-models for specific country groups[8]. In total, we estimate 12 models. Since using logarithms of variables enables us to interpret coefficients easily and is an effective way of shrinking the distance between values, we transform price-cost margin, electricity consumption and income level variables into logarithmic form and use these new transformed variables in our models.

We perform the empirical analysis by estimating the specification given in Equation (2) for each model[9]. However, as mentioned before, we cannot directly decide which regression specification (FE or RE) to use. Therefore, we apply Hausman test for fixed versus random effects in each model. To perform this test, we first estimate the fixed effects model (which is consistent) and store the estimates, then estimate the random-effects model (which is efficient) and run the test. Since we prefer 5% significance level, any p-value less than 0.05 implies that we should reject the null hypothesis of there being no systematic difference in the coefficients. In short, Hausman test with a p-value up to 0.05 indicates significant differences in the coefficients. Therefore, in such a case, we choose fixed effects model. However, if p-value from Hausman test is above 0.05, we cannot reject the null hypothesis of there being no systematic difference in the coefficients at 5% level. In such cases, Hausman test does not indicate significant differences in the coefficients. Therefore, we provisionally choose random effects. After that, we apply Breusch and Pagan Lagrangian Multiplier (BPLM) test for random effects in order to decide on using either pooled OLS or random effects in our analysis. This test is developed to detect the presence of random effects. In this test, the null hypothesis is that variances of groups are zero; that is, there is no unobserved heterogeneity, all groups are similar. If the null is not rejected, the pooled regression model is appropriate. That is, if the p-value of BPLM test is below 0.05, we reject the null, meaning that random effects specification is the preferred one. If it is above 0.05, we prefer pooled OLS

[8] FE estimation results do not let us detect the differences between country groups as variables that do not vary over time (like dummies for separating country groups) are dropped in FE estimation. In order to observe possible differences between country groups, we estimate separate models for each country group.

[9] Throughout the paper, model estimations are carried out and cross-checked by Stata 11.1 and Eviews 7.1.

specification to carry out our regression. Table 2 shows a summary of estimation results that present statistically significant coefficients and their standard errors. Full details of estimation results are provided in Appendix 1; including estimation output, number of observations and countries included in each model estimation, results of Hausman and BPLM tests and preferred specifications based on these tests.

Table 2. Summary of estimation results

Dependent Variables	Log of price-cost margin for industry				Log of price-cost margin for households				Absolute value of deviation from unit (=1) industrial/residential price ratio			
Explanatory Variables	All Countries	Developed Countries	Developing Countries in America	Other Developing Countries	All Countries	Developed Countries	Developing Countries in America	Other Developing Countries	All Countries	Developed Countries	Developing Countries in America	Other Developing Countries
Log of electricity consumption by industry	-0.702*** *(0.071)*	-0.947*** *(0.076)*		-1.295*** *(0.179)*	*NV*	*NV*	*NV*	*NV*				
Log of electricity consumption by households	*NV*	*NV*	*NV*	*NV*	-0.749*** *(0.063)*	-1.217*** *(0.069)*	-0.649*** *(0.176)*	-0.806*** *(0.144)*	0.052** *(0.027)*	0.091*** *(0.035)*	0.082* *(0.043)*	
Electricity loses in total supply (%, 0-100)	-0.021*** *(0.008)*	-0.094*** *(0.013)*		0.049** *(0.022)*	0.024*** *(0.006)*	-0.039*** *(0.009)*	0.030** *(0.012)*	0.126*** *(0.018)*		-0.018*** *(0.004)*		-0.029** *(0.012)*
Log of GDP per capita	0.735*** *(0.052)*	0.617*** *(0.046)*	0.865*** *(0.177)*	1.263*** *(0.164)*	0.873*** *(0.047)*	0.925*** *(0.041)*	1.361*** *(0.145)*	0.926*** *(0.146)*	*NV*	*NV*	*NV*	*NV*
Existence of IPPs	-0.191*** *(0.051)*	-0.116*** *(0.045)*	-0.641*** *(0.180)*									
Wholesale Electricity Market			0.746** *(0.293)*	-0.361* *(0.200)*				-0.474*** *(0.152)*		0.038* *(0.022)*		

Choice of Supplier					-0.218*** *(0.054)*			0.951*** *(0.174)*	0.112*** *(0.026)*			-0.277*** *(0.107)*
Unbundling				0.533*** *(0.190)*	0.187** *(0.078)*		0.695* *(0.370)*					
Privatization		0.188** *(0.074)*			0.241*** *(0.075)*	0.172*** *(0.057)*	1.030* *(0.574)*					
Existence of Market Regulator		-0.238** *(0.100)*					-0.579** *(0.235)*			0.068* *(0.038)*		0.169* *(0.093)*
Privatization and Regulator		0.193* *(0.103)*								-0.080** *(0.039)*		
Privatization and Unbundling		-0.280*** *(0.105)*					-1.512* *(0.793)*					
Unbundling and Regulator				-0.913*** *(0.284)*					-0.099** *(0.047)*	-0.098** *(0.040)*		
Constant	9.534*** *(0.710)*	12.592*** *(0.767)*	5.470*** *(2.052)*	15.555*** *(1.861)*	9.186*** *(0.557)*	14.088*** *(0.625)*	7.608*** *(1.469)*	9.035*** *(1.279)*				1.615** *(0.746)*

Standard errors are shown in parentheses () under coefficients.

NV: Not a variable in this model.

*** *Coefficients that are significant at 1% level.*

** *Coefficients that are significant at 5% level.*

* *Coefficients that are significant at 10% level.*

It is not easy to draw conclusions about the impact of extensive electricity market reforms in various countries from empirical work that focuses on a single market or from other country-specific anecdotal discussion of reform processes because neither type of study distinguishes the effects of reform from country-specific features. Therefore, our empirical approach was to take advantage of the diversity in electricity reform patterns in various countries and to control for a number of potential explanatory variables to predict three indicators: *electricity price-cost margin for households, electricity price-cost margin for industry and deviation from unit industrial/residential price ratio*. Panel analysis of price-cost margin trends (using reform indicators, country macroeconomic and other structural features) offers objective evidence on the observed impact of reforms at a macro level.

When we look at the results, we see that the signs of the coefficients for variables representing various reform steps differ, meaning that we cannot observe a uniform pattern concerning the impact of individual reform steps on price-cost margins and cross-subsidy levels, that is, different reform steps seem to have different impacts on price-cost margins and cross-subsidy levels. The interpretation of the results in detail is as follows:

Results from the models explaining price-cost margins for industry:

(1) In the first group of models, our empirical findings suggest that existence of independent power producers (IPPs) and electricity price-cost margins are negatively correlated for industrial users, meaning that participation of IPPs into generation market decreases price-cost margins, especially in developed countries and developing countries in America.

(2) Existence of wholesale electricity markets seems to decrease price-cost margins in developing countries in America while it has an increasing effect in other developing countries.

(3) We could not detect statistically significant results for choice of supplier and unbundling. Only exception is that unbundling alone is found to increase industrial price-cost margins. However, with regulator, it has a decreasing effect. Similarly, unbundling alone does not have a statistically significant impact on industrial price-cost margins in developed countries; however, with privatization, it has a decreasing impact.

(4) Our analysis also reveals that privatization and market regulator have statistically significant impacts only in developed countries. On their own, privatization increases industrial price-cost margins while existence of an electricity market regulator decreases them. If they exist together, they raise industrial price-cost margins in developed countries.

(5) We also observe a negative relationship between industrial electricity consumption and industrial price-cost margin, and a positive one between income level and industrial price-cost margin. This result implies that as industrial electricity consumption raises industrial price-cost margins decline while an increase in income level causes price-cost margins to increase.

(6) Proportion of electricity losses in total power supply has different impacts on price-cost margins in developed and developing countries. In developed countries, it decreases industrial price-cost margins while the opposite holds true in developing countries.

Results from the models explaining price-cost margins for households:

(7) Unlike the first group of models, we could not detect any significant impact of IPPs on price-cost margins in the second group of models. This result suggests that IPPs affect industrial prices only. When we take into account the fact that IPPs usually sell the electricity they produced to large industrial consumers, this result seems reasonable.

(8) Apart from developing countries in America, establishment of wholesale electricity markets has a decreasing effect on residential price-cost margins in developing countries.

(9) In general, choice of supplier seems to decrease residential price-cost margins while it appears to increase them in developing countries except for those in America.

(10) Our study finds that, on their own, unbundling and privatization raise residential price-cost margins. However, with privatization, unbundling has a decreasing effect on residential price-cost margins in developing countries in America.

(11) Based on results, it may be argued that existence of a market regulator reduces residential price-cost margins in developing countries in America.

(12) Similar to results from the first group of models, we observe a negative relationship between residential electricity consumption and residential price-cost margins, and a

positive one between income level and residential price-cost margins. This result suggests that as electricity consumption by households increases, residential price-cost margins reduce. On the other hand, as income level increases so does residential price-cost margins.

(13) As for the impact of electricity losses on residential price-cost margins, it seems to have an increasing impact for developing countries and decreasing one in developed ones.

Results from the models explaining absolute value of deviation from unit price ratio:

(14) Our results do not suggest a statistically significant impact of existence of IPPs, unbundling and privatization on cross-subsidy levels between industrial and residential consumers. However, combined with a market regulator, both unbundling and privatization seem to decrease cross-subsidy levels especially in developed countries.

(15) Our findings imply that existence of wholesale electricity market and market regulator increase cross-subsidy levels in developed countries. Market regulator also raises the cross-subsidy in developing countries apart from those in America.

(16) In general, choice of supplier seems to result in an increase in cross-subsidy levels while it decreases it in developing countries except for those in America.

(17) We could not detect a statistically significant relation between industrial electricity consumption and cross-subsidy levels. On the other hand, residential electricity consumption appears to be positively correlated with cross-subsidy levels, meaning that as electricity consumption by households increases so does cross-subsidy between industrial and residential consumers.

(18) Our findings also reveal that proportion of electricity losses in total supply is negatively correlated with cross-subsidy levels.

It should also be mentioned that dummy variables representing various reform steps have relatively weaker impact on price-cost margins and cross-subsidy levels in almost all models. Based on our results, we may argue that electricity consumption, income level and network losses are more influential in explaining price-cost margins and cross-subsidy levels than reform process. Finally, we see that country specific features tend to have a high power in explaining price-cost margins and cross-subsidy levels.

To sum up, based on our results, we could not argue that the reform process as a whole decreases or increases price-cost margins and cross-subsidy levels. Individual reform steps have diverse impacts on the price-cost margins and cross-subsidy levels in different countries. Therefore, we cannot reject *or* fail to reject Hypothesis 1 and Hypothesis 2 for whole reform process. However, we may evaluate our Hypotheses for each individual reform step. For instance, in the case of existence of IPPs or market regulator, we fail to reject Hypothesis 1. That is, participation of IPPs into generation sector or existence of a market regulator results in a decline in electricity price-cost margins. On the other hand, we reject Hypothesis 1 for unbundling or privatization, existence of which seems to increase price-cost margins. Besides, wholesale electricity market and choice of supplier appear to have different impacts on different consumer and country groups. Similar remarks can be made for Hypothesis 2 too. For instance, our results imply that existence of a market regulator alone increases cross-subsidy levels while, combined with unbundling, it decreases them especially in developed countries.

6. Limitations of the study

The research may have a number of limitations that we acknowledge. In fact, we have no reason to believe that any of these limitations should be existent in our analysis, but cannot of course rule them out.

To begin with, like all other econometric studies on electricity reform, the issue of endogeneity may be raised in our study. The analysis dealt to some extent with this potential problem by including country and year fixed effects. The country fixed effects control for country-specific propensities to reform and matters such as institutional characteristics, and year fixed effects control for any general trend in the reform of electricity sector.

Another shortcoming may originate from the lack of data. Due to limited nature of our data set, we could not properly account for the impact of some other variables on electricity price-cost margins like institutional characteristics, technological innovations and changes to regulatory practices. For instance, a possible source of bias in our study is that the model does not control for market power or institutional structure of the electricity industry. Besides, problems associated with price conversions using exchange rates tend to reduce the usefulness of cross-country data.

Some aspects of electricity reforms are not readily quantifiable in physical or monetary units (Jamasb et al., 2004). That is to say, objective comparisons across countries are inherently difficult in any study and our analysis is not an exception. The main steps of electricity reform process are usually established progressively and have a qualitative dimension. In this study, we used dummy variables to account for various reform measures. Although such an approach seems a practical and reasonable representation of reform dimension, we cannot argue that we reflected all characteristics of the various reform processes in our study.

Our sample is composed of 63 countries for which we could obtain data on all variables in our model. There will be sample selection bias if the countries making this data available have differing results for the dependent variables than those which do not make data available. Moreover, different countries may have different classifications and reporting conventions, so that observations in a given data series may not have the same meaning across all countries. Taken together, any measurement error and omission of explanatory variables may bias estimates of all coefficients in the models. However, in our study, omitted variables may be captured at least in part by the country-specific effects, mitigating the potential for bias.

In this study, we used electricity prices in national currencies converted by IEA and OLADE into US$/kWh using the exchange rates to the U.S. dollar. As we know, if two countries have differing rates of inflation, then the relative prices of goods in the two countries, such as electricity, will change. The relative price of goods is linked to the exchange rate through the theory of Purchasing Power Parity (PPP), which states that the exchange rate between one currency and another is in equilibrium when their domestic purchasing powers at that rate of exchange are equivalent. Purchasing power parities take into account different rates of inflation among different economies and equalise the purchasing power of different currencies. In other words, they eliminate the differences in price levels between countries in the process of conversion. However, due to problematic nature of calculation process of PPPs, we do not use PPPs in this study. Although our approach ignores the inflation in the US, it does so consistently and uniformly across countries. Therefore, it does not pose an important setback to our analysis.

While our analysis serves as one of the first steps in assessing the impact of reform process on electricity price-cost margins, much work remains to be done. There is still much room for improvement within the models and data presented in this paper. The analysis can be enhanced by refining the regulatory indicators and finding a suitable proxy for market power. Furthermore, as done in many other similar studies, we treated large countries like United States, Australia, Canada and India, in which the development of liberalization varies from state to state, in the same way as developing countries that came late to liberalization. Thus, in the future, we need to develop new methods to reflect the impact of the size and scale of these countries.

7. Policy implications and conclusion

The true value of electricity reform is a matter of empirical testing rather than theoretical debate. Opponents of the reform may point to spectacular reform failures (e.g. California disaster), or its advocates may try to get general conclusions from some success stories of a few reforming countries (e.g. NordPool). However, what is really needed is a complete study of the impact of reforms within the context of a well defined model construction. Besides, today, there are data on electricity market reforms going back about three decades and available data start to let us meaningfully establish which market model and industry structure optimize social welfare. This study tried to fill the gap by offering a macro level econometric analysis on the possible effects of reform process on electricity price-cost margins.

One of the main *expectations* from power market reform has been a reduction in price-cost margins and cross-subsidy levels. Throughout the study, we focused on these issues by using empirical econometric models to observe the impact of electricity market reforms on price-cost margins and cross subsidy levels. Panel data from 63 countries covering the period from 1982 to 2009 were employed. As a result of the study, we could not detect a uniform pattern for the impact of reform process as a whole on price-cost margins and cross subsidy levels. Our results suggest that each individual reform step has different impact on price-cost margins and cross subsidy levels for each consumer and country group. In a word, our findings imply that similar reform steps may have different impacts in different countries, which supports the idea that reform prescription for a specific country cannot easily be transferred to another one with similar success. Therefore, while deciding whether to initiate a reform process *or* in the process of making decisions on the direction of an already initiated reform process, policy makers should take into account the fact that each reform step has a specific impact in each country based on each country's specific circumstances. More than that, countries that try to adopt the power market structure of another country (for example, the adoption by developing countries of electricity industry model similar to the UK) will have very different performance characteristics than the original country because their country-specific conditions will be different. The main implication of our results is that transferring the formal and economic structure of a successful power market in a developed country to developing countries is not a sufficient condition for good economic performance of the electricity industries in developing countries.

Our conclusions do not necessarily involve a judgement on the overall success *or* failure of the reform process. The reduction in electricity price-cost margins and cross-subsidy levels is just one of the expectations from the reform and the process should be judged based on its overall impact (not only its impact on price-cost margins and cross-subsidy levels). What's more, it may well be argued that the reform process has just started or is still under progress in many countries and today it is too early to measure its impact on price-cost margins. These and similar arguments can not be rejected straight away. Moreover, it is obvious that present econometric evidence on the impact of the reform process is quite limited. So, there is a definite need for continued analyses of the effect of reforms in the electricity industry. Much work needs to be done and there are ample opportunities for research in this area. In many countries, power market reform is still an on-going process, a fact that also underlines the need for continued and up-to-date study. We believe that panel datasets rather than simple cross-section models should be used in future studies, preferably including pre- and post-reform data. Furthermore, so far, most of the studies have focused on a single reform element or outcome (e.g. reform steps, prices, performance, costs and so on) but there is a need for cross-country econometric studies measuring overall impact of the reform process.

We admit that power market reform is complex and the evidence is difficult to evaluate. We also recognize that it is too early to reach any concrete judgment for future policy suggestions based on the results from this paper and other comparable studies. An exact reckoning of the long-term effects of reforms on price-cost margins will require much additional study over longer periods of time.

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Appendix 1. Estimation results

Models	Dependent variable *(country group)*	Explanatory variables	Coef.	Std. Err.	t-stat.	p value	Number of countries	Number of observations	Hausman Test		BPLM Test		Preferred Specification
									Statistic	p-value	Statistic	p-value	
Model 1.1	Log of price-fuel cost margin for industry *(All countries)*	Log of electricity consumption by industry	**-0.702**	0.071	-9.860	**0.00**	54	1,049	67.54	0.0000	-	-	Fixed Effects
		Electricity loses in total supply (%, 0-100)	**-0.021**	0.008	-2.670	**0.01**							
		Log of GDP per capita	**0.735**	0.052	14.170	**0.00**							
		Existence of IPPs	**-0.191**	0.051	-3.760	**0.00**							
		Wholesale Electricity Market	0.021	0.066	0.310	0.75							
		Choice of Supplier	-0.038	0.066	-0.570	0.57							
		Unbundling	0.015	0.090	0.160	0.87							
		Privatization	0.142	0.088	1.610	0.11							
		Existence of Market Regulator	-0.005	0.095	-0.050	0.96							
		Privatization and Regulator	0.085	0.123	0.690	0.49							
		Privatization and Unbundling	-0.165	0.125	-1.320	0.19							
		Unbundling and Regulator	-0.093	0.119	-0.790	0.43							
		Constant	**9.534**	0.710	13.440	**0.00**							
Model 1.2	Log of price-fuel cost margin for industry *(Developed countries)*	Log of electricity consumption by industry	**-0.947**	0.076	-12.420	**0.00**	31	659	77.60	0.0000	-	-	Fixed Effects
		Electricity loses in total supply (%, 0-100)	**-0.094**	0.013	-7.410	**0.00**							
		Log of GDP per capita	**0.617**	0.046	13.300	**0.00**							
		Existence of IPPs	**-0.116**	0.045	-2.590	**0.01**							
		Wholesale Electricity Market	-0.059	0.058	-1.020	0.31							
		Choice of Supplier	0.056	0.066	0.840	0.40							
		Unbundling	-0.021	0.077	-0.270	0.79							
		Privatization	**0.188**	0.074	2.530	**0.01**							
		Existence of Market Regulator	**-0.238**	0.100	-2.380	**0.02**							
		Privatization and Regulator	**0.193**	0.103	1.860	**0.06**							
		Privatization and Unbundling	**-0.280**	0.105	-2.660	**0.01**							
		Unbundling and Regulator	0.065	0.106	0.610	0.54							
		Constant	**12.592**	0.767	16.410	**0.00**							

Models	Dependent variable (country group)	Explanatory variables	Coef.	Std. Err.	t-stat.	p value	Number of countries	Number of observations	Hausman Test		BPLM Test		Preferred Specification
									Statistic	p-value	Statistic	p-value	
Model 1.3	Log of price-fuel cost margin for industry *(Developing countries in America)*	Log of electricity consumption by industry	-0.293	0.219	-1.340	0.18	13	241	65.84	0.0000	-	-	Fixed Effects
		Electricity loses in total supply (%, 0-100)	0.009	0.017	0.550	0.58							
		Log of GDP per capita	**0.865**	0.177	4.880	**0.00**							
		Existence of IPPs	**-0.641**	0.180	-3.550	**0.00**							
		Wholesale Electricity Market	**0.746**	0.293	2.540	**0.01**							
		Choice of Supplier	(omitted)										
		Unbundling	-0.431	0.445	-0.970	0.33							
		Privatization	0.575	0.681	0.840	0.40							
		Existence of Market Regulator	0.309	0.288	1.070	0.28							
		Privatization and Regulator	-0.762	0.609	-1.250	0.21							
		Privatization and Unbundling	-0.250	0.943	-0.270	0.79							
		Unbundling and Regulator	(omitted)										
		Constant	**5.470**	2.052	2.670	**0.01**							
Model 1.4	Log of price-fuel cost margin for industry *(Other developing countries)*	Log of electricity consumption by industry	**-1.295**	0.179	-7.250	**0.00**	10	149	177.34	0.0000	-	-	Fixed Effects
		Electricity loses in total supply (%, 0-100)	**0.049**	0.022	2.240	**0.03**							
		Log of GDP per capita	**1.263**	0.164	7.710	**0.00**							
		Existence of IPPs	0.124	0.142	0.870	0.38							
		Wholesale Electricity Market	**-0.361**	0.200	-1.800	**0.07**							
		Choice of Supplier	0.286	0.221	1.290	0.20							
		Unbundling	**0.533**	0.190	2.810	**0.01**							
		Privatization	0.175	0.244	0.720	0.48							
		Existence of Market Regulator	0.081	0.185	0.440	0.66							
		Privatization and Regulator	-0.019	0.526	-0.040	0.97							
		Privatization and Unbundling	0.228	0.549	0.420	0.68							
		Unbundling and Regulator	**-0.913**	0.284	-3.210	**0.00**							
		Constant	**15.555**	1.861	8.360	**0.00**							

Models	Dependent variable *(country group)*	Explanatory variables	Coef.	Std. Err.	t-stat.	p value	Number of countries	Number of observations	Hausman Test		BPLM Test		Preferred Specification
									Statistic	p-value	Statistic	p-value	
Model 2.1	Log of price-fuel cost margin for households *(All countries)*	Log of electricity consumption by households	**-0.749**	0.063	-11.860	**0.00**	53	1,115	86.82	0.0000	-	-	Fixed Effects
		Electricity loses in total supply (%, 0-100)	**0.024**	0.006	3.790	**0.00**							
		Log of GDP per capita	**0.873**	0.047	18.610	**0.00**							
		Existence of IPPs	-0.012	0.042	-0.290	0.77							
		Wholesale Electricity Market	0.066	0.054	1.230	0.22							
		Choice of Supplier	**-0.218**	0.054	-4.020	**0.00**							
		Unbundling	**0.187**	0.078	2.400	**0.02**							
		Privatization	**0.241**	0.075	3.230	**0.00**							
		Existence of Market Regulator	-0.115	0.081	-1.420	0.16							
		Privatization and Regulator	0.098	0.106	0.920	0.36							
		Privatization and Unbundling	-0.149	0.107	-1.400	0.16							
		Unbundling and Regulator	0.126	0.102	1.240	0.22							
		Constant	**9.186**	0.557	16.510	**0.00**							
Model 2.2	Log of price-fuel cost margin for households *(Developed countries)*	Log of electricity consumption by households	**-1.217**	0.069	-17.550	**0.00**	31	714	247.20	0.0000	-	-	Fixed Effects
		Electricity loses in total supply (%, 0-100)	**-0.039**	0.009	-4.270	**0.00**							
		Log of GDP per capita	**0.925**	0.041	22.440	**0.00**							
		Existence of IPPs	-0.001	0.034	-0.040	0.97							
		Wholesale Electricity Market	0.020	0.043	0.460	0.64							
		Choice of Supplier	-0.035	0.049	-0.720	0.47							
		Unbundling	0.053	0.060	0.880	0.38							
		Privatization	**0.172**	0.057	3.010	**0.00**							
		Existence of Market Regulator	0.016	0.079	0.210	0.84							
		Privatization and Regulator	0.020	0.081	0.250	0.80							
		Privatization and Unbundling	-0.095	0.081	-1.170	0.24							
		Unbundling and Regulator	-0.018	0.083	-0.220	0.83							
		Constant	**14.088**	0.625	22.520	**0.00**							

Models	Dependent variable *(country group)*	Explanatory variables	Coef.	Std. Err.	t-stat.	p value	Number of countries	Number of observations	Hausman Test		BPLM Test		Preferred Specification
									Statistic	p-value	Statistic	p-value	
Model 2.3	Log of price-fuel cost margin for households *(Developing countries in America)*	Log of electricity consumption by households	**-0.649**	0.176	-3.680	**0.00**	13	244	85.26	0.0000	-	-	Fixed Effects
		Electricity loses in total supply (%, 0-100)	**0.030**	0.012	2.540	**0.01**							
		Log of GDP per capita	**1.361**	0.145	9.390	**0.00**							
		Existence of IPPs	-0.104	0.154	-0.680	0.50							
		Wholesale Electricity Market	0.093	0.228	0.410	0.68							
		Choice of Supplier	(omitted)										
		Unbundling	**0.695**	0.370	1.880	**0.06**							
		Privatization	**1.030**	0.574	1.790	**0.07**							
		Existence of Market Regulator	**-0.579**	0.235	-2.460	**0.02**							
		Privatization and Regulator	0.767	0.504	1.520	0.13							
		Privatization and Unbundling	**-1.512**	0.793	-1.910	**0.06**							
		Unbundling and Regulator	(omitted)										
		Constant	**7.608**	1.469	5.180	**0.00**							
Model 2.4	Log of price-fuel cost margin for households *(Other developing countries)*	Log of electricity consumption by households	**-0.806**	0.144	-5.600	**0.00**	9	157	113.35	0.0000	-	-	Fixed Effects
		Electricity loses in total supply (%, 0-100)	**0.126**	0.018	6.820	**0.00**							
		Log of GDP per capita	**0.926**	0.146	6.330	**0.00**							
		Existence of IPPs	0.134	0.125	1.070	0.29							
		Wholesale Electricity Market	**-0.474**	0.152	-3.110	**0.00**							
		Choice of Supplier	**0.951**	0.174	5.480	**0.00**							
		Unbundling	0.269	0.207	1.300	0.20							
		Privatization	0.121	0.216	0.560	0.58							
		Existence of Market Regulator	-0.249	0.172	-1.440	0.15							
		Privatization and Regulator	0.109	0.470	0.230	0.82							
		Privatization and Unbundling	0.037	0.488	0.080	0.94							
		Unbundling and Regulator	-0.119	0.281	-0.420	0.67							
		Constant	**9.035**	1.279	7.060	**0.00**							

Models	Dependent variable *(country group)*	Explanatory variables	Coef.	Std. Err.	t-stat.	p value	Number of countries	Number of observations	Hausman Test		BPLM Test		Preferred Specification
									Statistic	p-value	Statistic	p-value	
Model 3.1	Absolute value of deviation from unit (=1) industrial/ *residential price ratio* *(All countries)*	Log of electricity consumption by industry	-0.017	0.025	-0.680	0.50	61	1,364	15.60	0.2104	969.71	0.0000	Random Effects
		Log of electricity consumption by households	**0.052**	0.027	1.960	**0.05**							
		Electricity loses in total supply (%, 0-100)	-0.001	0.002	-0.760	0.45							
		Existence of IPPs	-0.007	0.019	-0.390	0.70							
		Wholesale Electricity Market	-0.020	0.027	-0.730	0.47							
		Choice of Supplier	**0.112**	0.026	4.340	**0.00**							
		Unbundling	-0.025	0.039	-0.650	0.51							
		Privatization	-0.030	0.036	-0.830	0.41							
		Existence of Market Regulator	0.038	0.030	1.270	0.21							
		Privatization and Regulator	-0.031	0.049	-0.630	0.53							
		Privatization and Unbundling	0.024	0.049	0.490	0.63							
		Unbundling and Regulator	**-0.099**	0.047	-2.110	**0.04**							
		Constant	0.118	0.124	0.950	0.34							
Model 3.2	Absolute value of deviation from unit (=1) industrial/ *residential price ratio* *(Developed countries)*	Log of electricity consumption by industry	0.003	0.036	0.090	0.93	31	687	24.61	0.0168	-	-	Fixed Effects
		Log of electricity consumption by households	**0.091**	0.035	2.620	**0.01**							
		Electricity loses in total supply (%, 0-100)	**-0.018**	0.004	-3.970	**0.00**							
		Existence of IPPs	-0.017	0.017	-1.020	0.31							
		Wholesale Electricity Market	**0.038**	0.022	1.760	**0.08**							
		Choice of Supplier	0.037	0.025	1.480	0.14							
		Unbundling	-0.001	0.029	-0.030	0.98							
		Privatization	0.015	0.027	0.570	0.57							
		Existence of Market Regulator	**0.068**	0.038	1.810	**0.07**							
		Privatization and Regulator	**-0.080**	0.039	-2.060	**0.04**							
		Privatization and Unbundling	0.013	0.039	0.320	0.75							
		Unbundling and Regulator	**-0.098**	0.040	-2.460	**0.01**							
		Constant	-0.419	0.286	-1.470	0.14							

Models	Dependent variable *(country group)*	Explanatory variables	Coef.	Std. Err.	t-stat.	p value	Number of countries	Number of observations	Hausman Test		BPLM Test		Preferred Specification
									Statistic	p-value	Statistic	p-value	
Model 3.3	Absolute value of deviation from unit (=1) industrial/ *residential price ratio (Developing countries in America)*	Log of electricity consumption by industry	-0.013	0.037	-0.350	0.73	21	520	10.53	0.5697	146.41	0.0000	Random Effects
		Log of electricity consumption by households	**0.082**	0.043	1.900	**0.06**							
		Electricity loses in total supply (%, 0-100)	0.000	0.002	0.120	0.91							
		Existence of IPPs	0.030	0.044	0.690	0.49							
		Wholesale Electricity Market	-0.032	0.088	-0.360	0.72							
		Choice of Supplier	0.167	0.105	1.590	0.11							
		Unbundling	0.080	0.299	0.270	0.79							
		Privatization	-0.116	0.170	-0.680	0.49							
		Existence of Market Regulator	-0.048	0.052	-0.920	0.36							
		Privatization and Regulator	0.141	0.202	0.700	0.49							
		Privatization and Unbundling	0.025	0.144	0.180	0.86							
		Unbundling and Regulator	-0.294	0.296	-0.990	0.32							
		Constant	-0.126	0.171	-0.730	0.46							
Model 3.4	Absolute value of deviation from unit (=1) industrial/ *residential price ratio (Other developing countries)*	Log of electricity consumption by industry	-0.201	0.153	-1.320	0.19	9	157	116.29	0.0000	-	-	Fixed Effects
		Log of electricity consumption by households	0.129	0.141	0.910	0.36							
		Electricity loses in total supply (%, 0-100)	**-0.029**	0.012	-2.410	**0.02**							
		Existence of IPPs	-0.080	0.074	-1.080	0.28							
		Wholesale Electricity Market	0.061	0.089	0.680	0.50							
		Choice of Supplier	**-0.277**	0.107	-2.600	**0.01**							
		Unbundling	-0.101	0.098	-1.030	0.30							
		Privatization	0.120	0.125	0.960	0.34							
		Existence of Market Regulator	**0.169**	0.093	1.810	**0.07**							
		Privatization and Regulator	-0.383	0.264	-1.450	0.15							
		Privatization and Unbundling	0.102	0.277	0.370	0.71							
		Unbundling and Regulator	0.128	0.144	0.890	0.37							
		Constant	**1.615**	0.746	2.170	**0.03**							

Note: The coefficients that are significant at 10% level are shown in **bold**.