Electricity Market Reform: Lessons for developing countries

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1. Introduction

This report presents the doctoral research done during the first year of the PhD study. The research is concerned with the analysis of the outcomes of electricity market reforms that have been put into practice in more than half of the countries in the world (see Section 3). The analysis is predominantly empirical with a special focus on electricity industries. Originally, this research was inspired by the experiences of the author, who was working for the energy market regulator in his home country before commencing his PhD studies in Cambridge. The final PhD thesis will be in three-paper format. Although it has not been fully completed yet and is still in progress, the first paper and preliminary results from it are presented in this report. We also briefly mention subsequent papers here; however, their final structure will be determined in the following years of the PhD study.

Electricity is an indispensable good for households and a key input for industry in almost every economy. Its importance is so obvious that we do not need to spend further time to explain it. Since 1980s, vast amounts of financial resources and effort have been spent on reforming electricity industries in both developed and developing countries. Reforms were pioneered by Chile, the UK, and Norway; and have spread all over the world. In almost all reforming countries, electricity reform has been a part of wider policies towards a liberal market economy. In the process of reform, the former vertically integrated electricity utilities were restructured and unbundled, and competition has been introduced into generation, wholesale and retail segments of the industry. Transmission and distribution businesses have usually remained as regional or national monopolies but they have been put under regulation by an independent sector regulator. Other common elements of the reforms include introduction of wholesale and spot power markets, establishment of impartial market and system operators, removal of restrictions on third party access to networks and, in some cases, privatization.

The motivations for changing the power industry structure vary from country to country, but in general, it is expected that successful reforms can improve the efficiency of the sector and offer lower price-cost margins and better quality of service. In developing countries, an additional objective may be added as attracting investment into the power sector (Sioshansi, 2006b).

Three decades have elapsed since the introduction of first reforms and there is now a need for a detailed evaluation on the economic impact of the reforms because the reforms appear to be costly and there seems to be a growing controversy about their benefits. It is, therefore, important to examine whether evidence supports and verifies the logic of reforms, as suggested in Jamasb and Pollitt (2005) and Pollitt (2009a, 2009b, 2008b). A number of empirical studies have tried to measure the impact of regulatory reforms in a variety of ways but they have mostly failed to provide a macro perspective as most of them focused on a single country or a few countries, as reviewed in Mota (2004) and Pollitt (2009b). Only a small number of scholars have made a contribution in conducting cross-country analysis of the impact of regulatory reforms in the electricity industries. Even in these studies, analyses were conducted using very limited data and the number of countries analyzed was quite small. So, there is a huge research gap in this very important area. Using a panel data on 92 countries covering whole reform period so far (1982-2009), this study attempts to fill this gap to a certain degree. Besides, to the best of our knowledge, present study will be the most extensive one in terms of both scale and scope.

To summarize, the proposed PhD thesis will consist of three independent but related papers where the preliminary results from the first one are presented in this report. The expected contributions of these papers are the following. The first paper focuses on the impact of the power market reforms on the convergence of residential and industrial electricity price-cost margins in various countries towards their average value and on cross-subsidy levels between consumer groups. In almost all reforming countries, one of the main targets of power market reforms has been price-cost margins. By introducing cost-reflective pricing, improving efficiency (and, thereby, reducing costs) in the sector; the reforms are expected not only to make electricity price-cost margins in different countries converge towards their average but also to reduce cross-subsidy levels between consumer groups in both developed and developing countries. The first paper questions these expectations and checks whether reforms really cause electricity price-cost margins to move towards the average value and cross-subsidy levels to go down. Second paper will deal with other objectives of the reform process, especially quality of service, efficiency and investment issues. The last paper is planned to focus on the institutional and qualitative aspects of the reform process and try to find out why reforms are successful in some countries while they fail in others.

The report is structured as follows. Following section presents literature review and the reform experience so far. This section summarizes the studies using econometric methods to analyze electricity market reforms and mentions country experiences to give the reader a flavour of what has been done so far. However, an extensive account of the reform process is both not an objective of this paper and well outside its scope. Section 3 describes the research gap, research questions and data collection issues. Section 4 presents the first paper, titled "*The impact of power market reforms on convergence towards the average price-cost margin: a cross country panel data analysis*". Subsequent section briefly mentions the second and third papers and outlines PhD research plan. Final section concludes.

2. Literature review and the evidence so far

2.1. Studies using econometric methods to analyze electricity market reforms

Jamasb et al. (2004) classify approaches to analysing electricity reforms into three broad categories: (i) econometric methods, (ii) efficiency and productivity analysis methods, and (iii) individual or comparative case studies. They argue that econometric studies are best suited to the analysis of well-defined issues and the testing of hypotheses through statistical analysis of reform determinants and performance. According to them, efficiency and productivity analyses are suitable for measuring the effectiveness with which inputs are transformed into outputs, relative to best practice. Jamasb et al. (2004) also maintain that single or multi-country case studies are suitable when in-depth investigation or qualitative analysis is needed. Within this classification, our study well suits the first category. Therefore, in this section we summarize econometric studies that focus on cross-country evidence on the impact of electricity market reforms. Non-econometric studies, econometric studies looking at just one or a few countries and studies that are not directly related to electricity markets are outside the scope of this section.

The empirical analysis by Steiner (2001) constitutes one of the earliest analysis of the reform process. Steiner (2001) looked at 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 study, Steiner (2001) carried out a panel data analysis including electricity price, ratio of industrial to residential electricity price, capacity utilization rate and reserve margin. Using these variables, she tried to measure the competitive aspects and the cost efficiency of reform. She also looked at some reform elements separately, including unbundling, wholesale power pool, third party access to transmission and privatization. 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.

Bacon and Besant-Jones (2001) tested two hypotheses in their study. The first one was that country policy and institutions are positively correlated with reform, and second was that country risk is negatively correlated with reform. Their results supported both hypotheses. The coefficient on the policy indicator and the coefficient on the risk indicator were significant and had the expected signs. In addition, they detected some regional effects. For instance, they found that Latin American and Caribbean countries are more likely to reform while countries in the Middle East and Africa are more likely to take fewer reform steps.

The study by Ruffin (2003) dealt with the institutional determinants of competition, ownership and extent of reform in electricity reform process. The institutional determinants employed are different measures of judicial independence, distributional conflict and economic ideology. The study used a cross-section OLS regression analysis of a set of models with observations of up to 75 developed and developing countries that reformed their electricity industries during the 1990s. Ruffin (2003) also used institutional explanatory variables with the electricity reform scores that reflect the extent of reform. The study found that the relation between judicial independence on the one hand, and competition and ownership on the other, is ambiguous; i.e. the coefficients are often insignificant or, when significant, their sign shifts across models. Besides, greater distributional conflict was found to be significantly correlated with a higher degree of monopoly. Moreover, the results showed that the relation between economic ideology favouring competition and private ownership was generally positive and significant. The results also pointed out that there is a positive relationship between judicial independence and reform scores. Furthermore, economic ideology showed a positive and mostly significant relation with the reform score in this study.

Hattori and Tsutsui (2004) examined the impact of the regulatory reforms on prices in the electricity industry. Like Steiner (2001), they also used panel data for 19 OECD countries but for the period 1987-1999. Hattori and Tsutsui (2004) found that, first, expanded retail access is likely to lower the industrial price, while at the same time increasing the price differential between industrial and household customers. Second, they concluded that the 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 the 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 significant higher prices and also increased the ratio of industrial price to household price, although not in a statistically significant manner. Finally, 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. Their finding that unbundling of generation and the introduction of a wholesale spot market have resulted in a higher price is not consistent with expectations and differs from Steiner (2001).

Zhang et al. (2005) concentrated on the sequencing of competition, regulation and privatisation in reform processes in developing countries. They studied the effect of the sequencing of privatisation, competition and regulation reforms in electricity generation using data from 25 developing countries for the period 1985-2001. They used a fixed effects panel data model. They found that establishing an independent regulatory authority and introducing competition before privatisation is correlated with higher electricity generation, higher generation capacity and, in the case of the sequence of competition before privatisation, improved capital utilisation.

Pollitt (2009b) mentions two other empirical studies that examine the price impacts of reform by Ernst & Young (2006) and Thomas (2006a). 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; liberalized markets increase price volatility; liberalization inhibits investment; liberalized markets provide reliable and secure supply; and liberalized markets interact effectively with other public policies (such as on climate change). Thomas (2006a) examined a number of reports including those of European Commission which look at (or comment on) electricity prices. He argued although these studies 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 believes 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.

Zhang et al. (2008) provided an econometric assessment of the effects of privatization, competition and regulation on the performance of the electricity generation industry using panel data for 36 developing and transitional countries over the period 1985-2003. The study identified the impact of these reforms on generating capacity, electricity generated, labour productivity in the generating sector and capacity utilization. The main conclusions were that on their own privatization and regulation (PR) do not lead to obvious gains in economic performance, though there are some positive interaction effects. By contrast, they concluded, introducing competition seemed to be effective in stimulating performance improvements.

The most recent studies on econometric modelling of electricity market reforms were two papers by Nagayama (2009, 2007). 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 (IPPs), 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 also found that privatization, the introduction of foreign IPPs and retail competition lower electricity prices in some regions, but not in all of them. In his second paper, Nagayama (2009) aimed at clarifying whether the effects of electric 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 electric power prices on the selection of a liberalization model in the power sector. This was achieved by the use of an ordered response, fixed effect and a random effect model. An instrument variable technique was also used to estimate the impact of the liberalization model on the electric 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, a finding also noted by Joskow (2008), in the context of the US. 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.

Based on this brief literature review on cross-country econometric studies related to electricity market reforms, we may argue that present econometric evidence on the impact of the reform process is quite limited and will take more time to emerge. Therefore there exists a huge research gap in this area. Besides, we believe that panel datasets rather than simple cross-section models should be used in future studies, preferably including pre- and post-reform data. When dealing with extensive samples including observations from various developed and developing countries over long time periods, country and time effects should also be taken into account in regressions.

2.2. Country experiences on electricity market reforms

Today, in most of the European countries, US, Canada, Australia and some selected countries in Latin America, power sector reforms are already highly developed. On the other hand, countries in Africa and the Middle East have been late in implementing reforms and reforms have been gradually taking effect in Eastern Europe and Asia. This section briefly reviews the country experiences so far. Due to limitations on the length of the report, we could not provide an extensive account of the reform processes around the world, and therefore, our focus will be on countries that have introduced wide-ranging reform measures and on those with novel characteristics that are important for explaining reform process.

2.2.1. Electricity market reforms in Central and South America

The privatization and liberalization of the electricity sector in Latin America has progressed to the point where a competitive market has been established in such countries as Argentina, Bolivia, Chile, and El Salvador (Nagayama, 2007). However, state owned vertically integrated electricity utilities are still dominant in other parts of the region (e.g. Venezuela and Mexico). Electricity reforms in Chile and Argentina were the deepest and the most radical. In Bolivia, Colombia and Peru, electricity markets were restructured and opened to competition. Reforms in Brazil were more cautious and gradual (Gabriele, 2004). Most of the countries of the region have followed the Chilean model (Peru, Bolivia, and Argentina in the first stage), but Colombia followed the approach initially adopted in England and Wales (Hammons, 2003). In this sub-section, we will cover reforms in Chile, Argentina and Brazil; and briefly mention those in Bolivia and Peru.

Chile was the first country in the world that introduced reforms in its power industry. The electricity power law was enacted and a wholesale market was created in 1982. The state-owned electricity enterprise was privatised without its transmission systems being unbundled, leading to emergence of a private company with a virtual monopoly on the transmission sector. More specifically, new private company group (Endesa group) held a share of more than 90% in transmission network, controlled 80% of generating capacity and was the distributor for 43% of all customers in Chile (Nagayama, 2007). So, one group controlled generation, transmission and distribution, giving it sufficient leverage to exert market power. Today, the Chilean power sector is comprised of 31 generating companies, 5 transmission companies, and 36 distribution utilities, most of which are privately owned. Power generation and transmission operations have been liberalised, allowing free entry to and withdrawal from these businesses. Since no restrictions are imposed on foreign capital companies, numerous businesses have entered the market (Nagayama and Kashiwagi, 2007). As expected, the biggest challenges in Chile's power sector are issues related to reducing market power and promoting competition. The problems originated from the fact that a pool market model was adopted when there were a few big generation companies with market power. The inadequate unbundling of the generation and transmission sectors resulted in the transmission company being owned by a specific generation company, which worsened the situation. Finally, as result of an acute electricity crisis caused by a collapse of hydro output in 1998-1999 and ahead of an election, Chilean government intervened in the functioning of the market and assumed a greater decision making role in strategic investment and regulation.

Pollitt (2004) assessed the progress in Chilean reforms and its lessons. He found that the reform was very successful. He concluded that while the initial market structure and regulatory arrangements gave rise to certain problems, the overall experience argued strongly for the private ownership and operation of the electricity industry, with appropriate restructuring to create a competitive market.

Argentina was also one of the first countries in the world to implement an electricity market reform. Besides, market reform in Argentina has been regarded as one of the most successful ones as it achieved significant reductions in system losses and improvements in quality of supply (Haselip and Potter, 2010). The Argentine power sector reform was design based on the lessons learned from privatisation and reforms in Chile and the United Kingdom. Especially, full-scale unbundling in Argentina was in response to the problems that had been experienced in Chile, where insufficient unbundling and limitations on competition had damaged reforms. The electricity sector in Argentina was considerably restructured in 1992 as part of the reorganisation and privatisation programme. That is, the power sector reform was performed as part of the wider structural changes in the overall Argentine economy. It was also an attempt to address the impending energy crisis. In reform process, more than 80% of the generation, all of the transmission and 60% of the distribution sector were transferred into private ownership. Remaining public ownership was limited to the state owned nuclear power generating company and two hydro-electric plants (with part foreign ownership) in the generation sector and some provincially owned distribution companies (Pollitt, 2008a). The vertically integrated state owned company was restructured into 5 generation and 3 distribution companies. A system operator (CAMMESA) was established with equal equity participation by all interested parties in the market except for small customers and generators. The generation market was very successful and the most competitive one probably in the world in the late 1990s.

One rather novel aspect of reforms in Argentina is the arrangements for transmission expansion. With the reforms, transmission expansions in Argentina were no longer the responsibility of the transmission owner or regulator, but of the users of the transmission system. The public contest method required users to propose, approve and pay for major expansions. Approved expansions were then put out to competitive tender (Littlechild, 2008).

Until the macroeconomic crisis of 2002, power sector reforms in Argentina proved successful. This is illustrated by the decrease in electricity tariffs and the improved investment situation for generators in the decade between reforms being implemented and the economic crisis (Nagayama and Kashiwagi, 2007). With the devaluation of the peso in 2002, retail prices for electricity were frozen, which stopped investments and caused generators and distribution companies to suffer from losses as they cannot pass-through price increases to customers. To balance the disequilibrium between demand and supply caused by the tariff freeze, the government pursued a policy of price controls, subsidies and demand-side management measures. So, the politicisation of tariff setting process resulted in the setting of electricity tariffs at a level at which cost recovery was not feasible, which interfered with the functioning of the market.

Although after the crisis the achievements of the reforms were severely limited by the government's poor energy policy and intervention into the market for political reasons; today the framework of liberalization is sustained and still functional in Argentina. Pollitt (2008a) draws two sets of lessons from Argentina's electricity reforms for developing countries. First, comprehensive electricity reform can work in a developing country. Second, well organised markets and effective network regulation are undermined if there is unnecessary political interference in the pricing of electricity.

Brazil started to reform its power sector in 1995 with privatization of its major electricity utility (Eletrobras). IPPs were allowed to enter the Brazilian market and generation companies were privatized. Besides, a nationwide power grid operator and a wholesale electricity market were established. However, the vast complexity of the Brazilian electricity industry, incompletely defined regulatory structure; a lack of effective planning and an unstable economy hindered the flow of investments necessary to guarantee the system's expansion. As a result, the Brazil experienced a rationing of electrical energy that lasted from June 2001 to February 2002 (De Souza and Legey, 2010). The 2001 crisis vividly demonstrated Brazil's vulnerability to drought due to an excessive dependence on hydro-power and its low reserve margins (Lock, 2005). In response to this crisis, after 2004, Brazil shifted its electricity policy to emphasize long-term stability instead of free market. Brazilian government established a new regulatory framework for electricity. This new framework has three broad objectives: (1) to create an efficient mechanism for the contracting of electricity on behalf of captive consumers; (2) to ensure security of supply at the lowest possible prices; and (3) to provide universal access to electricity to consumers around the country (Dutra and Menezes, 2005). The 2004 revision introduced new practices in Brazilian power market. To begin with, two distinct contract environments are defined. The first environment is the regulated contracting environment (ACR) and second one is free contracting environment (ACL). The former has the purpose of protecting captive (small) consumers, while the latter allows for "free" (large) customers to choose their electricity suppliers. Within the ACR, a distinction is made between "new" and "existing" electricity. The aim is for final consumers to pay a combination of a higher price associated with new plants and a lower price associated with existing, partially, or fully depreciated plants. In this contracting environment, distributors are required to contract their entire forecast demand for captive consumers with generators, importers, and retailers. Contracts will be auctioned off over time with different auctions for new and existing electricity under a lowest-tariff criterion. Other new practices included the revitalization of mid- and long-term planning, the introduction of long-term agreements to guarantee the return of investments in new plants, and the uncoupling of distribution services from any other activities.

Mota (2003) conducted a study on the social welfare impacts of the privatization process in Brazilian distribution and supply markets during 1995-2000 period. The study adopted a social cost-benefit methodology and found that net benefits were significant, but producers absorbed most of the net gains. The paper concluded that had regulation been tougher since the beginning, consumers could have benefited more from privatisation. In another study by Mota (2004), a representative sample of privatised Brazilian companies is benchmarked against comparable United States investor-owned utilities. The study found that the efficiency gap among Brazilian and the US companies had been closing since privatisation. Even, the analysis of efficiency scores showed that Brazilian companies outperform their US counterparts, that is, Brazilian companies have on average higher efficiency scores than US utilities for almost all model specifications and for both 1994 and 2000. Overall, the study suggested that reforming distribution and supply can bring substantial benefits for developing countries, especially when both privatisation and incentive-based regulation are introduced. The results also provided support for the role of regulation in ensuring adequate capacity expansion, lower system losses, and the transfer of productivity gains to consumers.

Bolivia's electricity reforms occurred in the context of a debt crisis. Electricity reform was a component of wider economic reform. Even before reform, generation and distribution were already partly unbundled with diverse ownership. However, vertically integrated state utility (ENDE) controlled 80% of generation and operated the grid. The power sector in general and ENDE in particular provided satisfactory service, operated efficiently with relatively low system loses and were profitable at the time of reforms as tariffs were set above cost recovery levels. In 1994, the sector was fully unbundled. ENDE was turned into three private generation companies and a private transmission company. Privatization of the sector was completed by 1998. A wholesale market was created and consisted of regulated contracts supplemented by a competitive spot market, with distribution utilities required to buy 80% of expected demand on 3-year contracts. These arrangements have so far resulted in significant investment in expansion and upgrades. The World Bank closely involved in Bolivia's electricity reform and considered it a success in terms of sector finance and operations, and the government's fiscal goals (Williams and Ghanadan, 2006).

Peru also implemented neo-liberal market reforms in the electricity sector in the early 1990s, as part of a broader economic restructuring and in response to a crisis in its electricity system from 1986 to 1990 (Pérez-Reyes and Tovar, 2009). In 1990, the electricity rates were increased and sate electricity utility (Electro Peru) was restructured. Moreover, several state-owned companies were privatized but a significant important group of privatized companies were renationalized in 2002. The reforms were an attempt to attract private capital to finance the expansion of the power supply mainly in the generation sector. As a result of reforms, electrification levels increased from 45 percent in 1992 to 75 percent by 2002. Service quality also improved markedly (Cherni and Preston, 2007).

Anaya (2010) performed a study to assess the social welfare impact of the restructuring and privatisation of the electricity market in Peru. Two target companies in the study accounted for 64% of the total distribution market and 100% of the privatised distribution companies. She examined actual and counterfactual operating costs and performed a separate analysis for each company due to the differences in terms of economies of scale and market structure. She also computed the benefits from being connected on counterfactual scenarios. She used non-privatized companies (benchmark companies) for making appropriate comparisons and for determining preferred counterfactual cost decline. The study results showed that privatisation was worthwhile and that the social welfare of being connected had an important contribution to it. She concluded that government and producers benefited the most and consumers the least due to price increases.

2.2.2. Electricity market reforms in Europe

Traditionally, electricity utilities were vertically integrated in many European countries, with state or municipally owned enterprises playing an important role. The market was highly regulated with very limited opportunities for users to switch to alternative suppliers. There was no third party access to the transmission grid (Fiorio et al., 2007). After the pioneering experiences of some member and neighbour states such as the UK and Norway in the 1980s, the European Union (EU) began an effort of gradual electricity liberalization starting with the first Directive in 1996. The first directive was a compromise between countries that had started liberalization and those that contemplated it as a very remote possibility (Trillas, 2010). EU directive of 1996 required 15 member countries to open their retail markets at least partially by 2000. By 2000, all EU member countries, except Greece, had opened their retail markets. The other objectives in the directive include account separation between potentially competitive and monopolistic segments; freedom of choice for large consumers; and increasing autonomy of transmission networks. However, it still accepted negotiated third party access to networks. The directive was criticised for allowing countries too many ways of avoiding complying with the spirit of the reforms; not requiring a wholesale market or a market regulator to be set up. The unbundling requirements did not guarantee independence of access to the network and the negotiated third party access (TPA) option offered the incumbent companies a way to keep out competitors. Retail competition was restricted, with no more than a few thousand consumers able to choose by 2003 even in the largest countries (Thomas, 2006b).

The new Electricity Directive was agreed in 2003 and it placed more stringent requirements on member states to disintegrate their electricity industries and introduce competition in generation and retail supply. EU directive of 2003 required all member states to open the retail market to all customers excluding residential use by July 1, 2004 and to achieve complete liberalization by July 1, 2007. The negotiated TPA and single buyer options were withdrawn and access to the network has to be via regulated TPA. Member States are also required to appoint an independent sector regulator. Other key objectives to be achieved by 1 July 2007 in each member state include the legal unbundling of transmission and distribution businesses from competitive generation and supply, free entry into generation markets and regular monitoring of the progress of supply competition.

European Commission adopted a third package of energy market reforms in 2009; however the new electricity directive/regulation will come into force in 2011. This new package aims at extending earlier reform packages in 1996 and 2003. At the centre of the third legislative package, there are consumer choice, fairer prices, cleaner energy and security of supply. In order to reach those goals, the Commission proposes to separate production and supply from transmission networks; to facilitate cross-border trade in energy; to improve the effectiveness of national regulators; to promote cross-border collaboration and investment; to increase market transparency on network operation and supply and to increase solidarity among the EU countries.

Overall, all directives aimed at creating a strongly market-based system and a single European electricity market. However, many of the EU member states are reluctant in implementing these measures. A particular problem in the EU is the lack of will among member states and the EU Commission to reduce the market power of dominant companies. They prefer to maintain or allow the emergence of "national champions" in the electricity sector. This preference also explains why the EU electricity reform model does not include privatization of any of the currently state owned assets. At present, in most of the European countries, the incumbents' shares lie between 85 and 95 per cent and the incumbents are not challenged by competition from new entrants. In Italy, Denmark, France, Germany, the Netherlands and Belgium, switching rates remain below 10 per cent. They are slightly above 10 per cent in Finland and Spain. Only three countries exhibit net switching rates exceeding 20 per cent: Great Britain, Sweden and Norway (Defeuilley, 2009).

Today, a number of electricity market models coexist in Europe and they are different from one another in terms of the type of ownership, degree of openness, market concentration, and the degree of vertical integration. So, it is very difficult to argue that a unique European pattern of reform is emerging. In this section, we will briefly mention reforms in the UK, France, Germany, Italy, Nordic countries, Spain, Poland, Slovenia, Romania, Greece and Turkey.

In the UK, vertically integrated state owned power utility (CEGB) was restructured in 1990 to separate out transmission (as the National Grid Company) and three generation companies: National Power, PowerGen, and Nuclear Electric. All except Nuclear Electric were privatized, although the modern stations of Nuclear Electric were subsequently sold as British Energy in 1996 (Newbery and Pollitt, 1997). Shortly prior to privatisation, 12 regional electricity distribution companies (RECs) replaced the 12 area boards and transmission became the responsibility of the National Grid Company (NGC), a company fully owned by the RECs (Jamasb and Pollitt, 2007). Also, a mandatory-pool system was introduced in 1990. However, due to overwhelming market power exercised by power generation utilities, it could not effectively decrease electricity prices and therefore was abolished later. Since then, the British market has gone through two more stages of reform: one by New Electricity Trading Arrangements (NETA) introduced in 2001 and second by the British Electricity Trading and Transmission Arrangements (BETTA) in 2003.

The British electricity reform involved all the elements of a full sector reform including restructuring, privatisation, regulation, and competition. At present, the UK market is fully liberalised. All consumers can choose their own supplier. Since the starting of reforms, prices have fallen in real terms by about 25 per cent, system reliability has been maintained at high levels (Thomas, 2004). Although, a competitive market is achieved through further asset divestiture and new entry, vertical integration has not disappeared. Distribution is still a regional monopoly, often integrated with electricity and gas supply.

Newbery and Pollitt (1997) carried out a social cost-benefit analysis of the privatisation and restructuring of CEGB. In their study, they found that the main benefits came from generator efficiency gains, switching from nuclear power, and lower emissions. On the other hand, the main costs came from higher prices for imported French electricity, the cost of restructuring and premature investment in new gas-fired generating plant. Their central estimate was a permanent cost reduction of 5% per year, equivalent to an extra 40% return on assets. They found that, as a result of reforms, consumers and government lost, and producers gained more than the cost reduction. Another study on social cost-benefit analysis of British reforms was carried out by Domah and Pollitt (2001). They conducted a social cost-benefit analysis of the privatisation of 12 regional electricity companies in England and Wales by examining actual and predicted falls in costs over the period to 2005. They found that the privatisation yielded significant net benefits but that these were unevenly distributed across time and groups in society. They concluded that, relative to preferred counterfactual, consumers experienced slightly lower prices and the government gained £5 billion in sale proceeds and net taxes. However, they argued, consumers began to gain only from 2000.

British electricity market reform has been generally regarded as the example that other countries should follow. Consultants, encouraged by the World Bank and other international financial institutions, have recommended the adoption of the "British model" in countries with as diverse needs as India, Ukraine and Brazil; while the British model was clearly the inspiration for the European Commission's directives. However, some scholars are sceptical about the outcomes of the reform process in the UK. For instance, Thomas (2004) argue that the wholesale market in the UK is dominated by confidential long-term contracts; retail competition has disadvantaged small consumers and makes protecting the poorest consumers more difficult; integrated generation and retail supply companies dominate the market; and price regulation has evolved into a form of traditional rate-of-return regulation.

France can be considered as opposite of the British model. The French case is extraordinary in terms of its input mix to generate electricity. In 2008, 77% of the electricity was generated by nuclear plants, 14% came from hydro and renewable sources and just 9% from fossil fuels (US EIA, 2010b). In contrast to the UK, France was one of the latecomers in initiating reform and implementing the EU directives. Also, the reform in France has not led to a major change in the structure of the sector. Reform process in France begun only in 2000 when France approved a law to implement EC Directive of 1996. The reform included creation of a sector regulator, a regime of regulated third party access, introduction of a wholesale market and a progressive opening of the sector with the possibility for the consumer to choose the retailer. However, today, there is still a vertically integrated public monopoly or near-monopoly (EdF) in France operating at all stages from generation to transmission, distribution and sales. The government decided to introduce only a form of accounting separation between transmission and generation, essentially maintaining the vertical integration of the electricity sector.

Prior to the reform, there were a regime of private regional monopolies in Germany with nine vertically integrated regional companies, then merged in four groups which, in 2000, still controlled 80% of production, 40% of distribution and all transmission (Florio, 2007). In 1998, Germany adopted EU directives regarding the liberalisation of the sector. Since then, Germany has realized overall liberalization but without reorganization of vertically integrated power companies. The reform introduced full market opening, an electricity exchange and a regulatory body. Today, the German electricity market is still characterised by a high degree of vertical and horizontal integration dominated by a few large companies, which prevents competition and keeps barriers for new entrants and investments.

In 1999, Italy adopted EU directive of 1996 and liberalized its electricity sector by unbundling state owned vertically integrated company (ENEL), creating a state-owned transmission system operator, and privatizing some power stations of ENEL (a total capacity of 15,000 MW) to limit its market share to 50% after 2003. Today, the main problem in Italian power market is the dominant position of ENEL in basically all segments of the business. An additional obstacle to the development of effective competition is the majority stake of government in ENEL, which translates into significant political interference on the definition of the objectives as well as the management of the company (Ferrari and Giulietti, 2005). Today, ENEL still controls about 40% of the generation and the entire distribution network is virtually controlled by ENEL, with the exception of few cities where the local municipalities own the distribution companies.

Norway was the first among the Nordic countries to liberalise its electricity market in 1991, in line with British model but without privatisation. Today, the Norwegian electricity industry remains almost entirely in public hands. Rather than implementing their own reforms, the other Nordic countries chose to reform by merging with the existing Norwegian market. Nord Pool, the electricity power exchange with equity participation from each country's system operators, was founded by Norway and Sweden in 1996. Finland joined the NordPool in 1998 and Denmark in 1999. Reforms in the Nordic region seem to have been relatively successful, merging the four countries' (Norway, Sweden, Finland and Denmark) systems into one market. This success is apparent in the fact that unlike the California electricity market that collapsed following from severe demand and supply shocks in 2000-2001, the "lights have stayed on" in the Nordic market in spite of similar adverse supply and demand shocks in 2002-3 (Amundsen and Bergman, 2006). However, electricity prices in the region have increased as a result of a rise in electricity taxes and the introduction of the European system of CO_2 emission permits, which limited the popularity of the reforms in the region. Since the decisions to raise electricity taxes and to introduce emission permits have nothing to do with reform process, Nordic electricity market seems to work quite well so far. Amundsen and Bergman (2006) conclude that the main factors behind the relatively successful electricity market reform in the Nordic countries include (i) a simple but sound market design, to a large extent made possible by the large share of hydropower, (ii) successful dilution of market power, attained by the integration of the four national markets into a single Nordic market, (iii) strong political support for a market-based electricity market, (iv) voluntary, informal commitment to public service by the power industry. They also argue that the second and third of these factors are "transferable", while the first and fourth to a large extent are country-specific.

In Sweden, reform process was initiated in 1996. The retail market was fully opened and since 1996 the consumers can choose their own supplier. The transmission system remained in a non-profit public monopoly regime. The Finnish case is unique in the sense that even before the reform; the market was already very open (Pineau and Hämäläinen, 2000). Finland decided to reform the sector in 1995 and since then the market was progressively liberalized. In 1997, the consumers got the right to choose their supplier. The reform also established the separation between the transmission and generation firms although the distribution companies are not fully unbundled. The reform experience in Denmark was similar to that of the other Nordic countries and begun in 1996 and was completed in 2001 when consumers were granted the right to choose the supplier and the industry was totally unbundled. In Denmark, electricity sector is characterized by the presence of public local companies and, in spite of some privatization, the overall ownership structure still remains mostly public.

The reform of the energy sector begun in Spain with a law enacted in 1994 with the aim of liberalizing electricity sector. It mandated the legal unbundling of the transmission network and created an independent joint public-private transmission system operator (REE), which offered regulated TPA to both the transmission and the distribution networks. A new law was adopted in 1997 to accelerate the process of liberalization. Full market opening has been implemented in Spain since 2003. In 2006, the Iberian Electricity Market (MIBEL) was founded and aimed at creating an integrated electricity wholesale market with Portugal, notably by creating a single market operator for the wholesale Iberian pool market. Today, although there exists a market regulator, what consumers end up paying and firms receiving is ultimately determined by regulated tariffs, which are set by the government on an annual basis, and in a non-transparent manner. Also, the new system has failed in attracting new entry, and in promoting the efficient amount of investment needed to guarantee adequate reserve margins. Entry has been dissuaded by the incumbent firms. This has mainly been achieved by the strategic announcement of new investment plants that have never been carried out (Crampes and Fabra, 2005). The most relevant outcome of the electricity reform in Spain so far has been the emergence of some big firms that consolidated their generation assets. The market is mostly controlled by the three largest companies.

In Poland, electricity reforms took place within the context of Poland's post-Cold War transition from socialist to market economy. Before the reform, whole energy sector was controlled by a single vertically integrated company. Between 1987 and 1990, electricity was separated from this structure, but remained a vertically integrated industry. In Poland, electricity tariffs were massively subsidized through housing subsidies; tariffs paid by residential consumers recovered only 1% of the cost of supply (Williams and Ghanadan, 2006). In 1990, the electricity sector was unbundled both vertically and horizontally into autonomous state-owned enterprises and a transmission company (PSE) was set up. In 1993, all distribution utilities and a number of generators were turned into joint stock companies, which were to be privatized through stock sales (with a limit of 50% on foreign ownership). PSE operated the grid as a single buyer based on power purchase agreements with the generators. In 1997, a wholesale market was created and replaced the single-buyer model. A spot market was also set up in 2000. Reform process has raised tariffs to near 90% of full cost recovery, but at a high cost in public support for reforms. At present, Polish market witnesses rebundling and vertical reintegration. Two big state-owned utilities (representing almost half of Poland's electricity market) were created by merging a number of generation, distribution companies and some coal mines (Williams and Ghanadan, 2006). This move reflects a growing view in many small EU member sates that large, state-supported utilities will be more competitive in a unified EU market than small unbundled companies. The same trend has been witnessed in Slovenia as well. As a new member state of the EU, Slovenia has been required to adopt EU legislation in full and opened its electricity market fully in 2007 when all consumers became eligible. Electricity reforms in Slovenia included market liberalization, unbundling of activities, allowing regulated TPA, formation of an organized power market, adoption of incentive-based price cap regulation and the establishment of an independent regulatory body. Like Poland, Slovenia has merged the majority of the state owned power plants into a holding of electricity companies (HSE) in 2001 (Hrovatin et al., 2009).

In Romania, the vertically integrated, state owned monopoly was divided into five separate state owned enterprises over the 1998-2000 period: one each for nuclear generation, hydro generation, thermal generation, transmission, and distribution. Since then the distribution function has been further divided into eight regional companies, five of which were privatized. The wholesale market has been operating in Romania since 2000 and the market was fully liberalized in 2007 and all consumers can choose their supplier since then (Diaconu et al., 2009).

Electricity market in Greece was also dominated by a vertically integrated, state owned company (PPC) until the reforms. Greece embarked on electricity market liberalization in 2001 both to comply with EU directives and to encourage private investments. PPC was converted to a share company but remained under state control. A mandatory pool system was set up and full market opening has applied since 2007. At present, PPC still holds a highly dominant position in both electricity generation and power supply markets. Customer tariffs applied by PPC, which holds 98% of consumers, are regulated by the state and their structure still includes large cross-subsidizations among customer categories. It is also claimed that the level of regulated electricity prices is below power generation costs (Iliadou, 2009). Besides, compliance with the EU legislation on unbundling has been delayed in Greece and is still poorly developed. Legal unbundling was introduced only in relation to transmission, while PPC remains the exclusive owner of the transmission and the distribution networks.

Being a candidate for EU membership since 1960s, Turkey has also closely followed EU directives. Before the reforms, as was the case in many European countries, the Turkish electricity industry was dominated by a state-owned vertically integrated company (TEK). In 1982, public monopoly on generation was abolished and the private sector was allowed to build power plants and sell their electricity to TEK. In 1984, TEK was restructured and gained the status of state-owned enterprise. In 1993, TEK was incorporated into privatization plan and split into two separate state-owned enterprises, one for generation and transmission (TEAS) and other for distribution (TEDAS). In 2001, the reform process in electricity market was initiated. TEAS was restructured to form three new state-owned public enterprises: a transmission company (TEIAS), a generation company (EUAS) and a wholesale company (TETAS) (Erdogdu, 2010, Erdogdu, 2009, Erdogdu, 2007). Turkey's electricity distribution network was further divided into 21 distribution regions. TEDAS, which owns 20 of the 21 regions, was included in the privatization programme, and a separate distribution company was established in each of these 20 regions. Only three of these companies have been privatized so far and all others are still owned by TEDAS. There has been no progress in generation privatizations.

2.2.3. Electricity market reforms in Eurasia

In Eurasia region, each country's power sector consisted of a vertically integrated public sector monopoly immediately following the break-up of the Soviet Union. Since then, each country has adopted a different strategy with respect to industry structure. These strategies have included different types of vertical unbundling, regulation, privatisation and restructuring. Here we will focus on reforms in Russia, Ukraine, Armenia, Georgia, Azerbaijan and some countries in Central Asia.

In Russia, reforms were adopted more as an ideological undertaking than as a result of economic necessity. Reforms in general aimed at diminishing the power of party-state in general and incumbents in particular. Actually, the electricity sector in Russia was doing better than many other countries and was as developed as those in the US or UK (Yi-chong, 2006). Without serious problems, changes were not so radical. The reform's another objective was to attract domestic and foreign private investment to modernise and develop the electricity system (Engoian, 2006). The restructuring of Russia's power generation sector will be complete when state monopoly (RAO UES) dissolves. The country's transmission grid will remain under state control. The reform has created a generation sector divided into multiple wholesale electricity companies, which participate in a new competitive wholesale market. The creation of six wholesale electricity companies was completed in 2006. Today, there are seven separate regional power systems in the Russian electricity sector. RAO UES, which is 52 percent owned by the Russian government, controls most of the transmission and distribution in Russia. It owns 96 percent of the transmission and distribution system, and the wholesale electricity market (FOREM).

Electricity reform in Ukraine started in 1996. Vertically integrated national companies were unbundled and single-buyer model with compulsory pool market was adopted. Privatization process of the electricity companies began in 1997 but was cancelled in 1999 due to corruption. The reforms in Armenia, Georgia and Azerbaijan were in general in the form of privatization and aimed at attracting foreign investment. Armenia began power sector reform in 1997. Unbundling and privatization in distribution were carried out, and foreign capital introduction was realized. In Georgia, unbundling was executed in 1997, along with privatization of the power generation company and the distribution companies (Nagayama, 2007). In Azerbaijan, key restructuring initiative was to separate electricity distribution from generation and transmission, and to auction concessions to the private sector for the management of its four distribution companies (Mehta et al., 2007). At present, transmission and generation assets are held by vertically integrated state-owned enterprise. Further vertical unbundling is unlikely to proceed.

Kazakhstan has gone much further than any other country in the region in terms of power sector reform. It initiated unbundling and privatization in 1996. The government first unbundled power generation from transmission, and privatized most of the power generation capacity. Transmission and distribution were remained under public domain but performed by separate government-run companies. In 1998, the power wholesale market was established. Today, Kazakhstan has multiple generators that sell bulk power at unregulated prices and wholesale prices are negotiated between suppliers and buyers, who may choose which generators to contract with (Nagayama, 2007). In Tajikistan, vertically integrated public utility was corporatized in 2001 to facilitate further structural changes and improve the commercial performance of the sector. But, apart from this, no reform steps has been taken so far. Kyrgyzstan also corporatized its vertically integrated electricity utility but it also unbundled it into several generation companies, a transmission company, and four distribution companies in 2001. Each of these companies is currently publicly owned but has managerial autonomy.

2.2.4. Electricity market reforms in North America

For most of its history the US electricity sector has been dominated by large, vertically integrated, and heavily regulated private utilities. The U.S. has never implemented a mandatory comprehensive federal electricity market reform program, leaving the most significant reform decisions to the states. As a result, many U.S. states have introduced only limited liberalization without fundamental electricity sector restructuring (Joskow, 2008).

Beginning in the late 1970s, some steps were taken to reform traditional structure. By the late 1990s, extensive disintegration, considerably looser regulation, and more market-oriented operation were characteristics of the new US electricity industry. The reforms were mainly intended to bring competition to wholesale market. Competition among independent generators was supposed to create a framework for wholesale power transactions so that retail customers and local distribution utilities could purchase power from a wide range of alternative suppliers. The result was supposed to be lower wholesale costs and thus lower retail prices. By the year 2000, about half of the states either had restructured their electricity sectors or was planning to do so (Kwoka, 2008). Sioshansi (2008) argue that the pace of growth in retail competition has slowed in recent years in US and the transition to a national competitive electricity market has stalled. He cites the reasons for this as (i) the spectacular failure of the California market, (ii) mixed results in a number of states that have introduced retail competition, (iii) problems in some wholesale markets that have not performed as expected, and (iv) a lack of interest by the US Congress to push retail competition at the national level. Among these reasons, California crisis needs further focus. The California electricity market reform had promised to deliver reliable service at low and stable prices. The California electricity deregulation process was put into effect in 1998. In the period prior to reform, there was a considerable excess generation capacity and electricity prices were above normal. The reform program included the introduction of new institutional arrangements such as power exchange and independent system operator, restructuring, fixing end-user prices at 1996 level and a ban on new long-term power purchase contracts. Public power companies were excluded from the deregulation process but had to continue providing cheap electricity. The summer of 1998 showed tendencies to excessive wholesale prices but apart from this there was no particular problem and the market seemed to function fairly well until 2000. Prices on the wholesale market started to increase in the early summer of 2000 and continued to do so in the following months. The first of several forced black outs took place in June 2000. During this period the three major companies started to lose money on a large scale and became unable to pay for their power purchases. Consequently, the power generation companies became reluctant to sell power on the power exchange as their contracts were not honoured. The cap on end-user prices effectively hindered that rising wholesale prices transformed into rising end-user prices that would otherwise result in a reduction of consumption. Also, the restrictions on the long-term power contracts implied lacking hedging opportunities. Finally, the power exchange broke down and was declared bankrupt in March 2001 (Amundsen and Bergman, 2006). Woo (2001) identifies the major factors that contributed to California crisis as follows: poor market design, market power, demand growth (due to extremely warm weather during the summer of 2000) not matched by new capacity, a sizable reduction of hydro power generation (due to dry weather conditions), rising marginal cost (due to an increase in the price of natural gas by some 70 percent from April to November 2000), and financial insolvency. He also concludes California experience suggests that a reversible regulatory reform is a safe alternative to an irreversible market reform (for further details, see Sweeney (2002)).

The problems in California and elsewhere brought further restructuring to a halt in US but many states were irreversibly committed to deregulation. At present, electricity restructuring is substantially complete in some regions of the US, although other regions are much less affected.

In Canada, electricity reform started in the province of Alberta in 1996 where competition was introduced into power generation, and a wholesale electric pool was created. Alberta had a positive experience with reform leading to substantial new investment and reduction and stabilisation of prices. On the other hand, in Ontario, political mismanagement of a power crisis led to reform being abandoned and government interference into prices (Sioshansi, 2008).

2.2.5. Electricity market reforms in Asia and Oceania

Like Eurasia, power market reforms in Asia and Oceania have been gradually taking effect in some countries but halted in others. In this sub-section we cover the reform experiences in Australia, New Zealand, India, China, Japan, Philippines, South Korea and Hong Kong.

The 1990s witnessed a substantial reform in the Australian electricity sector. Since 1991, the industry has been broken up into its constituent parts; a national wholesale market for electricity was created, competition was introduced to electricity generation and retail supply sectors. The reform process was initiated in the State of Victoria for the first time in Australia. Victoria's vertically integrated electricity company was divided into generation, transmission and distribution/retail. Later, distribution/retail was further divided into five companies with separate franchise areas and generation was broken up into seven separate generation companies. Until 1997, these companies were privatized. In 1994, a wholesale electricity pool was established in Victoria and it was merged with the New South Wales wholesale market in 1998, creating the national wholesale electricity market. After the creation of national wholesale market, ownership and operation of the transmission system was separated and a public company was made responsible for the operation of the system. As a whole, the introduction of competition and privatization led to substantial improvements in productive efficiency. Capital utilization rates greatly increased and staff numbers reduced. The largest gainers from the reform process were the large industrial and commercial consumers, who were able to take advantage of competition among retailers. Households saw little change in the real average price of electricity (Abbott, 2006). Today, the progress of liberalization varies from state to state in Australia. New South Wales, Victoria, and Queensland have achieved liberalization in the retail sector while West Australia still maintains a vertically integrated structure.

From 1992 to 1995, significant reforms took place in New Zealand electricity market. In 1992, an electricity law was passed and it provided liberalization of the market and regulation of transmission and distribution segments. In 1998, another law was enacted and required forced ownership unbundling of electricity distribution from the rest of the electricity industry. Until 2001, there was no explicit sector regulator and the regulation was left to general competition authority. In 2001, a specific sector-focused regulation was introduced and electricity market regulatory commission became operational in 2003. Nillesen and Pollitt (2008) examined the impact of the policy of forced ownership unbundling of electricity distribution on electricity prices, quality of service and costs. They found that ownership unbundling did not achieve its objective of facilitating greater competition in the electricity supply industry but that it led to lower costs and higher quality of service. They concluded that this experience indicated the potential benefits of ownership unbundling in Europe but also the danger of unintended consequences.

In India, electricity theft, corruption, and a highly cross-subsidized pricing structure have made it nearly impossible for the utilities to improve power service. The quality and reliability of electricity have been so low that industrial consumers across India exit the state-run system and rely on their own on-site power generation (Joseph, 2010). India initiated power sector reforms in 1991 when the country was facing a political and economic crisis and was under pressure to open up the economy as part of a reform package agreed with the International Monetary Fund (IMF) and World Bank. IPPs were allowed to enter the power generation business and were offered attractive incentives. Although the initial interest was overwhelming, the enthusiasm was short-lived as only a few projects actually materialised. Second wave of significant attempts for reform came in the late 1990s. During this period, the State Electricity Boards (SEBs) began to be unbundled and even State of Orissa fully privatized its generation, transmission, and distribution assets. Besides, regulatory commissions were set up at the central and state levels and single buyer model was introduced. Soon, it was argued that deeper reforms were required to manage, regulate and co-ordinate development of the electricity industry in India. New legislative framework was adopted in 2003. The new act has de-licensed generation (except hydro), provided for the separation of system operation and transmission activities, allowed trading at wholesale and retail levels and permitted multiple licensing at transmission and distribution levels (Singh, 2006). However, despite the enactment of a comprehensive legal framework for governing the electricity industry, limited progress has been made in terms of achieving widespread sector liberalisation and privatisation in India (Bhattacharyya, 2007). At present, the electricity sector continues to perform poorly. There are still peak capacity shortages and energy deficits. Some consumers, like those in the agricultural sector, receive subsidized electricity and pay little or nothing for the electricity they consume.

China has the second largest electricity industry in the world and is playing an important role within the global economy. In the past two decades, it has also experienced a series of regulatory reforms in its electricity industry. With the development of the economy since the 1980s, the demand for electricity grew rapidly and power shortage became more serious than ever. In order to attract more investments to develop the electricity industry and relieve the bottleneck of power shortage, the investments from local governments, domestic enterprises and foreign investors in generation sector have been allowed since 1985. The Ministry of Electric Power was abolished in 1998, with its business functions transferred to the newly formed vertically integrated public utility (SPC), which was corporatized shortly. In 2002, SPC was divested and the generation sector was separated from the transmission and distribution sectors. Generation function was allocated to five big generation corporations. A regulatory body was set up in 2003 and the introduction of the wholesale electricity market is also in process (Du et al., 2009). Currently, the Chinese electricity industry has evolved into a dual system, with dominant state planning at the core, and a decentralised generation system at the periphery, owned by state organisations at different levels and by private enterprises. While the generation sector has some market competition, the transmission and distribution sectors are heavily state-controlled. There is still a chronic electricity shortage, with industrial consumers are frequently asked to shut down production during peak times and arrange production schedules at nights or weekends (Cherni and Kentish, 2007). As also concluded by Yeoh and Rajaraman (2004), China still has a huge task ahead of it to complete reform process. Because it places a higher value on political and economic stability than economic efficiency, and because of its unfamiliarity with a market economy, the transition to a competitive market could take many more years in China.

Electricity reforms in the Japanese electricity industry started in 1995 and for the first time IPPs were allowed to enter into the generating market by introducing the competitive bidding in the wholesale market. The government also introduced yardstick regulation, under which the electricity price of each electricity company is determined partly by comparing its performance with that of other companies. Companies with higher costs than others suffer losses, while those with smaller costs generate profits. Therefore, this system is expected to promote the cost cutting competition (Nakano and Managi, 2008). Partial liberalization in retail markets was introduced for large consumers in 2000 when power producers and suppliers were allowed to enter the market and use networks. Although the liberalization is limited in part by the fact that the retail power market has only about 30% share of total electricity demand, the eligible customers now have a choice among the nine major utilities and ten new entrants (Asano, 2006). Besides, Ida et al. (2007) found that first-period reforms, implemented in 1996-1999, were able to reduce costs by 7.5%; while second-period reforms, during the period of 2000 to 2002, effectively cut costs by 11.8% in Japanese electricity market, with respect to the base costs before regulatory reforms.

In Philippines, reform process initiated in 2001 when the government focused on introducing structural reform and market mechanism principles into the electric power sector. Reform objectives included full privatization of state-owned electricity utility, promotion of private participation in power market, establishment of a wholesale spot market and full liberalization of the market. However, in practice, many of these steps are behind schedule. The power prices were distorted due to the take-or-pay contracts with IPPs. Today, the sector reform is still ongoing in the Philippines and electricity prices are still among the highest in Asia. A wholesale electricity spot market was launched in 2006. Since there is no sufficient number of market participants to create a competitive environment, wholesale prices have not decreased.

Toba (2007) carried out an empirical investigation into the welfare impacts of the introduction of private sector participation into the Philippines electricity generation sector by liberalizing the market for independent power producers (IPPs) during the power crisis of 1990-1993. The study used a social cost-benefit analysis and found that the main benefits came from IPPs that contributed to resolving the crisis and promoted economic and social development. The paper concluded that consumers and investors were net gainers, while the government lost and there was an air pollution cost. Overall, the study found that the reform with private sector participation increased social welfare in Philippines.

South Korea began transforming the structure of its electricity industry from the public monopoly to market competition in 1998. Until then, the electricity industry of the country had been dominated by a state-owned vertically integrated company (KEPCO). The restructuring plan aimed at introducing market competition and privatization to the power industry, which was accompanied by the vertical unbundling and horizontal divestiture of KEPCO. As the first step of this plan, in 2001, the power generation function of KEPCO was divided into five thermal and hydropower generation companies and one company for nuclear power generation. Five companies were planned to be privatized over the next several years. However, in 2004, the Korean government suspended its electricity market reform based on the recommendation of a joint study team, which concluded in their final report that the alleged benefits of reform are theoretical and uncertain, while the real costs and risks are substantial. This suspension effectively interrupted the original plan adopted in 1998 by the previous administration to divest and privatize KEPCO's generation assets and introduce wholesale and retail competition (Lee and Ahn, 2006).

In Hong Kong, electricity has been supplied by two vertically integrated companies and both companies have been regulated under the Scheme of Control (SOC) agreements. A SOC agreement is a formal, long-term regulatory contract for 15 years, signed between a private firm and the government. Under the SOC, the two electric utilities are subject to rate-of-return and price control (Chan, 2006). The first SOC was signed in 1964. The industry under the SOC was relatively successful in providing sufficient and reliable electricity supply to meet Hong Kong's rapid economic growth, and therefore the agreement was extended in 1978 and again in 1993 (Lam, 2004). The government conducted a review on the regulatory and market model of the electricity supply industry in light of the expiry of the existing SOC agreements with the vertical integrated utilities in 2008. However, the SOC agreements were renewed as a result of review process and new agreements came into effect from 1 October 2008.

2.2.6. Electricity market reforms in Africa

The reforms in Africa were very limited in terms of scope and scale and almost in all reform cases the main motive was to encourage foreign private direct investment in power markets. In Africa, only few countries introduced a substantial reform program in their electricity industries. Here we will briefly mention reform experiences in South Africa, Ghana, Cameroon and Nigeria.

In South Africa, under the apartheid government, prior to 1994, government policies were geared at serving the needs of the minority white population group. Energy policies, including electricity provision, focused on ensuring sufficient supply for the mining, chemical and agricultural industries, which formed the backbone of the South African economy. When the new, democratic government came into power in 1994, South Africa's energy policy saw a fundamental shift in focus. In 1995 the government established the National Electricity Regulator as a successor to the Electricity Control Board that had been established in 1987. Electricity generation in South Africa has been dominated by Eskom, the state-owned electricity utility. Eskom owns, operates and maintains the national transmission grid and is thus a de facto monopolist on both the generation and transmission level. In 2002, Eskom was converted into a public company pursuant to the Eskom Conversion Act of 2001. At present, Eskom is regulated by the National Energy Regulator of South Africa (NERSA) in accordance with the Electricity Regulation Act of 2006. However, as suggested by Newbery (2009), little progress has been made in South Africa in terms of electricity sector reform.

Privatisation process was abandoned; regulator was created but the prices are still based on historic costs and, most importantly, demand has predictably outstripped the capacity. Today, Eskom continues to generate approximately 95% of the electricity used in South Africa.

Prior to reform, Ghana's small electricity sector consisted primarily of two state enterprises, one operated all generation and transmission (VRA), and the other was distribution utility (ECG). VRA performed well technically and financially, but ECG did not, with high system losses and poor service quality. Even after a series of increases, tariffs only recovered one-third of long run marginal costs and only 24% of the population had access to electricity in 1993. Electricity reform was triggered in 1993 by a supply crisis due to rapidly rising demand and drought. When the government approached the World Bank to finance new thermal generation, it was required to increase tariffs, remove barriers to private participation, and plan a comprehensive reform. An independent regulator was created. However, when a foreign aluminium factory declared bankruptcy in 2001 and pulled its operations out of Ghana, the country lost its largest consumer, and was left with excess capacity and expensive obligations to buy gas-generated thermal power. Today, electricity sector in Ghana continues to be a strain on the national budget. After a decade of reform, the basic structure of Ghana's power sector remained the same (Williams and Ghanadan, 2006).

In Cameroon, the government decided in 1996 to privatize the vertically integrated electricity utility (SONEL). At the end of five years of work devoted to the precise definition of the restructuring strategy of the sector, an American group (AES) acquired 51% of SONEL shares and signed a contract for a 20-year concession. The new entity borne out of this transfer was named AES-SONEL. Today, AES-SONEL has a monopoly on the generation, transmission, and distribution of electricity in Cameroon. So, reform process in Cameroon only resulted in a transfer of public monopoly into private one and has failed to promote social, environmental or economic sustainability (Pineau, 2002).

In Nigeria, state owned power utility (NEPA) was commercialized in 1988. In 2005, the monopoly of NEPA in electricity industry was broken and wholesale competition model was put into practice. NEPA was divided into 18 companies, including 6 generators, 11 distributors and one transmission company. Currently, the government holds the shares in the successor companies but it is planned that these companies would gradually be privatized (Ikeme and Ebohon, 2005).

3. Research gap, research questions and data collection

It has been shown in other economic sectors that market oriented reforms is a possible tool to improve economic performance, efficiency and welfare. In the electricity industries around the world, many reform programs have been put into practice since the early 1980s but there has been little cross-country applied research conducted on the economic consequences of such reforms. Although there is a relatively extensive literature on electricity market reforms in the form of opinion expression and case study discussions, the studies that adopt a cross-country perspective with a quantitative approach are extremely limited. In short, there is a real gap in the empirical literature with regard to the analysis of the consequences of the power market reforms. This is quite surprising given the economic importance of the sector both for individual countries and for the world economy, as well as the significant number of reform programs that have already initiated in many power sectors.

In the PhD study, we aim at assessing the outcomes of power market reforms by analysing cross-country data and developing a logical framework/models to evaluate empirical evidence from various countries. Throughout the study, we aim at answering following research questions:

i. What are the overall welfare effects of electricity market reforms, especially in developing countries? To be precise, does empirical evidence on electricity market reform support or verify the logic of reforms?
ii. What are the key differences between developing and developed countries in terms of electricity market design and how do these differences shape the outcome of reform process?
iii. What are the implications of electricity market reform process on development efforts in developing countries?
iv. Do some market designs work better in certain countries and under some system features than others?
v. What is the role of country-level factors such as the level of economic development, economic policies, and institutional structure in the success of the reform process?
vi. What is the impact of moving from a monopolistic electricity market structure towards a competitive one on the convergence of electricity price-cost margins in diverse

countries towards their average value and on cross-subsidy levels between consumer groups?

vii. How do reforms affect quality of service, efficiency and foreign direct investment in electricity markets?

viii. Is there an optimum sequencing of reform steps?

ix. How do country specific qualitative factors (e.g. educational background or ideological position of decision makers) influence the outcome of the reform process?

Ideally, empirical analysis of electricity reforms in the proposed PhD study will address all the questions above. However, data availability has considerable bearing on how and to what extent these questions are addressed. To answer these questions as fully as possible, we have collected data on various variables in relation to electricity reforms. Data collection process is not complete and, using different data collection methods, we will try to add additional variables that contribute to our analysis.

Currently, our data set includes a panel of 92 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. We included in our sample almost all countries where a kind of electricity market reform process has been initiated so far. Because of the missing observations, our panel is unbalanced. Due to limitations on the length of this report, we could not mention details of each variable but description of variables and sources of data can be found in Appendix section.

4. First Paper

The impact of power market reforms on convergence towards the average price-cost margin: a cross country panel data analysis

(In progress)

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Abstract

One of the main targets of power market reforms in the world has been price-cost margins. This paper focuses on this issue by looking at the impact of the power market reforms on the convergence of residential and industrial electricity price-cost margins in diverse countries towards their average value and 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, in most cases, reform process causes price-cost margins in different countries to move towards their average value. Besides, it is found that there is a negative relationship between absolute value of deviation from unit industrial/residential price ratio and the shift towards a competitive market model, meaning that as countries take more reform steps the size of cross subsidy between consumer groups tends to decline. Overall, based on empirical evidence, the study found that application of competitive market models in electricity industries makes electricity price-cost margins converge towards the average and prices more cost-reflective by reducing the size of cross subsidies between industrial and residential consumers, after controlling for

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[b] The author is a PhD candidate at Judge Business School and a member of Electricity Policy Research Group (EPRG) of University of Cambridge (UK). The present paper is still in progress and, when completed, will constitute one of the three papers that form his PhD thesis. The views, findings and conclusions expressed in this article are entirely those of the author and do not represent in any way the views of any institution he is affiliated with.

industry and country-specific variables. Furthermore, the study suggests that power consumption, income level, electricity losses and country specific features constitute other important determinants of convergence towards average electricity price-cost margin and cross-subsidy levels between consumer groups.

Keywords: *Models with Panel Data; Power Market Reform; Price-cost margin*

4.1. Introduction

It is a common knowledge that price and quality go hand in hand. It makes little sense to buy a cheap product without knowing its quality. The same applies for electricity; that is, cheap electricity does not really mean much if there are constant interruptions in the supply but paying huge sums of money for no interruptions at all does not make sense either. Since the early 1980s, billions of dollars have been spent on reforming electricity industries around the world and, price and quality have always been among the most important targets of power market reforms. It may well be argued that one of the most important objectives of the reform process has been setting these two indicators at optimum levels. In all reforming countries (whether developed *or* developing), reforms in power markets have aimed at realizing two common objectives: (i) reductions in absolute price-cost margins and making price-cost margins convergence towards the optimum level, and (ii) improvements in service quality. In this paper, we focus on the former while investigation of the latter is left to future papers.

By introducing cost-reflective pricing, improving efficiency (and, thereby, reducing costs) in the sector; the reforms are expected not only to make electricity price-cost margins in different countries converge towards their average but also to reduce cross-subsidy levels between consumer groups. 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 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 and improved efficiency in the industry, it is expected that the introduction of reforms in the electricity markets causes price-cost margins in different countries to move towards their average value. This paper tries to find out whether power market reforms have realized these expectations, or in other words, whether the reforms have moved price-cost margins towards their long-run average and made prices more cost-reflective by reducing the size of cross subsidies between consumer groups.

The paper also aims at clarifying whether the effects of power sector reforms 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 convergence towards average electricity price-cost margin and cross-subsidy levels. The econometric models are designed using panel data from 63 countries[1]. The dataset covers the period from 1982 to 2009.

We try to answer following research questions: (i) what is the impact of power market reforms on convergence towards the average electricity price-cost margin? (ii) does liberalization result in more cost-reflective prices by reducing cross-subsidies between consumer groups? (iii) what are the other factors that influence convergence towards the average electricity price-cost margin 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. 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 (2006a)). Since fuel costs are probably the most

[1] Based on income group and geographical region they belong to, countries are classified into three groups below. All countries defined as high-income economies by World Bank are grouped as developed countries. All other countries in our dataset are put together as developing countries (for further details, see WORLD BANK 2010a. World Bank Country Classifications, URL: http://go.worldbank.org/K2CKM78CC0.)

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.

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 econometric study 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 brief background to power market reform process and tries to clarify what the reform is. Section 4.3 presents a literature review on the impact of electricity sector reform process on electricity prices. Section 4.4 summarizes the methodological framework. Section 4.5 describes data. Following section presents empirical analysis and discusses the preliminary results. Section 4.7 mentions potential limitations of the study. Section 4.8 comments on the prospects of further development of the paper. The last section concludes.

4.2. Background to reform

Actually, the initial push for the creation of power grids was private but it was not long before deeper government involvement was evidenced. This occurred with varying degrees across countries, especially after World War II (Gratwick and Eberhard, 2008). However, whether private or not, electricity industry was regarded as a natural monopoly in almost all countries and structured as a vertically integrated utility. The rationale for this includes some judgements about the industry. First of all, it was believed that in the electricity sector one firm produces output less expensively than if there were multiple firms in the market as average costs declined as output increased. Government ownership of the monopoly (or public regulation) was also justified on the grounds that the state was the guardian of the public interest and therefore would be the least likely to act in an opportunistic manner, as monopolists were likely to do. Besides, ownership by only one firm also helped to ensure the necessary coordination among the different segments of the industry (generation, transmission, distribution and retail supply). Moreover, a general assumption was made about the strategic nature of the power industry for economic development, which justified both vertical integration and public ownership. In short, pre-reform structure of the electricity industry was primarily motivated by the existence of natural monopoly conditions, externalities, and *so-called* "public good" characteristics (Steiner, 2001). In fact, however, electricity industry is characterised by these characteristics on the whole but some of its functional segments do not possess these features. Functionally, electricity industry may be divided into generation, transmission, distribution, and supply. Transmission and distribution comprise natural monopoly segments of the industry because competition in these parts would result in duplication of the existing network. On the other hand, generation and supply functions have nothing to do with monopoly characteristics and therefore may be open to competition. However, historically, electricity industry as a whole was taken to be a natural monopoly, and legal monopoly model was adopted assuming that it is the most efficient one. In general, as mentioned above, power industry was organized and operated under one of two basic structures: as state-owned enterprises under government control or as privately owned regulated monopolies (Sioshansi, 2006a). Many countries (e.g. most of the European countries) consolidated and nationalised their electricity industries into state-owned, legal monopolies while some other countries (e.g. Japan, US, Germany, Hong Kong) created private but regulated monopolies. So, over the last century, a large number of vertically integrated power companies, whether state or privately owned, have emerged under both models around the world, dominating the business.

By the 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[2], development of gas-fired combined cycle gas turbines[3] (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

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[2] 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. *Journal of Regulatory Economics,* 21**,** 103-132.)

[3] 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.

subsidiary motives include the demonstration effects of the pioneering reforms of the power sectors in UK and Norway in the early 1990s; and rapid changes in technology especially in the generation of electricity that made new industrial structures 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). Besides, electricity reform in developed countries rested on the robust legal and institutional foundations of highly functional national political systems and aimed at optimizing the economic performance of an already well-developed industry. By contrast, in developing countries, reform took place within problematic legal and institutional contexts. Even, definition of success differs between developed and developing countries. In developed countries success of the reform depends mainly on how well the reformed electricity markets function; while in developing countries success usually means attracting capital from outside the country.

In addition to internal factors mentioned above, some factors external to the power sector also played a major role. The most important of these factors was finance. The oil shocks of the 1970s caused serious economic crisis in developing countries and resulted in an increase in foreign debt, budget shortfalls, and inflation. These crises led governments to put into practice structural adjustment programs with the aim of reducing public spending and increasing private investment into the economy. In addition to other sectors, these reforms also focused on liberalizing the energy industries. State industries such as electricity, gas, oil and mining were featured as having the greatest potential for revenue generation through commercialization and privatization. To sum up, both internal and external factors influenced the thinking of policy makers and economists, forcing them to question their long-held beliefs. As suggested by Sioshansi (2006a), Dubash (2003) and Reddy (2002), this was a true paradigm shift. This shift has also been strongly encouraged by the World Bank, IMF and other international financial institutions. In 1992, the World Bank officially changed its lending policy for electricity development from traditional project lending to policy lending. That is, any country borrowing from the Bank on power projects would have to agree to move away from a "single national electricity utility as a public monopoly" and adopt ownership, structural and regulatory reforms (Yi-chong, 2006). Other international financial institutions, such as the Asian Development Bank, European Bank for Reconstruction and Development, and the Inter-American Development Bank have followed suit (Williams and Ghanadan, 2006).

The power sector reform began in Chile in 1982, which then spread through various countries in the world especially after the 1990s. Bacon and Besant-Jones (2001) argue that the process of a full reform program consists of the following four main stages: (a) formation and approval of a power policy by government that provides political commitment needed to sustain the reform process, followed by the enactment of legislation necessary for implementing this policy; (b) development of a transparent regulatory framework for the electricity market; (c) unbundling of the integrated structure of the power supply into generation, transmission, distribution and supply activities and establishing a market in which electricity is traded; and (d) divestiture of the state's ownership at least in most of the electricity generation and distribution segments of the market. So, key elements of a reform, in the suggested order, are: (i) regulation, (ii) restructuring, and (iii) where possible, privatization (Jamasb, 2006). However, by no means all countries have adopted all of these changes; indeed, in most countries state ownership remains dominant, regulation remains largely untested, and competition is still restricted (Zhang et al., 2005). Moreover, in many cases, the initial market design had inherent flaws that only became apparent after the passage of some time. In nearly all these cases, initial market reform resulted in unintended consequences, which have been addressed in subsequent "reform of the reforms" (Defeuilley, 2009). In some instances, second and third waves of reforms have been initiated to address issues overlooked in the initial reform programmes. Today, reforms are ongoing in many countries and reform process in the power sector is regarded as not only possible and necessary, but also inevitable. In most reforming countries, we now have hybrid power markets with elements from both the old and new industry models.

4.3. 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 and following Pollitt (2009b), 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 (2009b) mentions two other empirical studies that examine the price impacts of reform by Ernst & Young (2006) and Thomas (2006a). 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 (2006a) 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.

Zhang et al. (2008) provided an econometric assessment of the effects of privatization and competition on residential and industrial electricity prices. They used data on 51 LDCs (Least Developed Countries) covering 1985-2000 period. In their study, the estimated coefficients are not significant for privatisation, and there is only partial support for the hypothesis that competition will lower industrial prices. Moreover, their results do not support the hypothesis that regulation will raise prices to domestic consumers.

Other two studies on econometric modelling of electricity market reforms come from two papers by Nagayama (2009, 2007). 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.

Table 1 presents a summary of previous econometric studies on the relationship between power market reforms and electricity prices.

Table 1. Summary of previous econometric studies on the relationship between power market reforms and electricity prices

Study	Hypothesis	Dependent Variable(s)	Explanatory Variable(s) [Result]	Control Variable(s) [Result]	Data samples and sources
(Steiner, 2001)	H: Regulation and restructuring leads to lower industrial electricity prices and industrial/residential price ratio.	* Industrial end-user price in PPPs * Ratio of industrial to residential prices in PPPs	* Time to liberalisation (years) [significantly positive for prices] * Time to privatisation (years) [insignificant for prices] * Unbundling of generation from transmission (multi-level indicator) [insignificant for prices] * Private ownership (multi-level indicator) [significantly positive for prices] * Third party access (dummy) [insignificant for prices and for efficiency measures] * Wholesale pool (dummy) [significantly negative for prices] * Choice threshold * Price regulation	* GDP (US$) [insignificant] * Hydro share in generation [significant for prices] * Nuclear share in generation * Preference against nuclear technology * Preference in favour of coal technology * Urbanisation	* Panel data from IEA/OECD and other sources covering 19 OECD countries from 1986-1996 (number of observations: 209)
Hattori and Tsutsui (2004)	H1: Unbundling of generation from transmission, third party access, the existence of a	* Industrial end-user price in PPPs * Ratio of industrial to residential prices in PPPs	* Wholesale pool (dummy) [significantly positive for prices] * Third party access (dummy) [significantly negative for prices]	* GDP (US$ PPP) [statistically significantly negative for prices] * Share of hydro capacity	* Panel dataset of 19 OECD countries for the period 1987-1999 (number of observations:

Study	Hypothesis	Dependent Variable(s)	Explanatory Variable(s) [Result]	Control Variable(s) [Result]	Data samples and sources
	wholesale market, and privatisation leads to lower industrial electricity prices and industrial/residential price ratios. H2: As the start of liberalisation and privatisation approaches prices decrease.		* Private ownership (multi-level indicator) [significantly negative for prices] * Time to privatisation (years) [statistically insignificant]	[statistically insignificant] * Share of nuclear capacity [statistically insignificant]	232)
Ernst & Young (2006)	H1: Liberalisation lowers prices. H2: Liberalization lowers costs and price-cost margins. H3: Liberalised markets drive price volatility.	* Industrial and commercial electricity prices	* The degree of market opening [statistically significant] * The percentage of market not covered by the three largest companies [statistically significant] * Composite indicator of competition combining the above indicators [statistically significant]		* EU-15 countries from 1985-1991, pooled cross-sectional six-monthly time-series * Source: EuroStat, UK Department of Trade and Industry (DTI)
Fiorio et al. (2007)	H: Electricity prices are affected by regulatory variables, such as vertical integration, public	* Household (net of taxes) electricity prices * Consumers' satisfaction on prices they pay	* Vertical integration [rather small and not statistically significant] * Public ownership	* Production costs [statistically significant] * Residential consumption * Efficiency losses	* EU-15 countries from 1978-2005 * Consumer satisfaction survey data from

Study	Hypothesis	Dependent Variable(s)	Explanatory Variable(s) [Result]	Control Variable(s) [Result]	Data samples and sources
	ownership and entry regulation.		[rather small and not statistically significant] * Entry regulation [rather small and not statistically significant]	* GDP [statistically significant] * Population [statistically significant] * Imports * Type of energy source	Eurobarometer survey for years 2000, 2002 and 2004 * Source: Eurobarometer, OECD/REGREF indicators, IEA, EuroStat
Nagayama (2007)	H: Introduction of each reform step is expected to lower the electricity price.	* Residential electricity prices in US$ PPP * Industrial electricity prices in US$ PPP	* Introduction of foreign IPP [statistically significant for some regions] * Privatization [statistically significant for some regions] * Unbundling [not statistically significant] * Establishment of regulatory institution * Introduction of wholesale spot market/power exchange [not statistically significant] * Introduction of retail competition [statistically significant for some regions]	* Per-capita GDP * T&D loss * The political democratic degree index * The import energy impact variable * Share of hydropower * Share of nuclear power	* Panel data for 83 countries during the period from 1985 to 2002 * Regions: Latin America, the former Soviet Union, and Eastern Europe * Source: IEA, MERALCO (Philippines), CEB (Sri Lanka), EVN (Vietnam), PLN (Indonesia), National Statistics Bureau (China), OLADE, EBRD, various government information sources

Study	Hypothesis	Dependent Variable(s)	Explanatory Variable(s) [Result]	Control Variable(s) [Result]	Data samples and sources
(Zhang et al., 2008)	H1: Competition leads to higher residential and lower industrial prices. H2: Regulation leads to higher residential prices.	* Residential prices in US$ * Industrial prices in US$	* Competition (for H1): existence of wholesale market (dummy) [this is significant for industrial prices for only one of the specified equations (at 1% level of significance)] * Regulation (for H2) : existence of independent regulatory agency (dummy) [insignificant]	* GDP per capita (US$ 95) [significant at the 1% level] * urban population as % of total [significant at the 1% level] * industrial output as % of GDP [significance varies across models] * degree of economic freedom (based on 10-point indices in "Economic Freedom of the World: 2002 Annual Report") [significant at the 1% level]	* 51 LDCs from 1985-2000 * Generation and capacity data: APERC database and World Development Indicators * Labour: Industrial Statistics Yearbook, International Labour Organisation * Privatisation, regulation, and competition: The Yearbook of Privatisation, EIA, WEC, and APERC * Price: OLADE, OECD
Nagayama (2009)	H1: As the electric power price level increases, it is expected that the electricity sector will be more liberalized and the political movements that encourage lower electric	* Liberalization model (in Model 1) * Residential electricity prices in US$ PPP (in Model 2) * Industrial electricity prices in US$ PPP (in Model 2)	* Residential electricity prices in US$ PPP (in Model 1) [statistically significant positive effect] * Industrial electricity prices in US$ PPP (in Model 1) [statistically significant positive	* GDP per Capita (1995 prices) [statistically significant positive effect]	* Panel data from 78 countries in four regions (developed countries, Asian developing countries, the former Soviet Union and Eastern Europe, and Latin

Study	Hypothesis	Dependent Variable(s)	Explanatory Variable(s) [Result]	Control Variable(s) [Result]	Data samples and sources
	power prices will increase.		effect] * Liberalization model (in Model 2) * Political democratic degree index (in Model 2)		America) for the period from 1985 to 2003 * Source: IEA, MERALCO (Philippines), CEB (Sri Lanka), EVN (Vietnam), PLN (Indonesia), National Statistics Bureau (China), OLADE, EBRD, World Bank

4.4. Methodology

4.4.1. Indicators, their measurement and causal relationships among them

As underlined by Jamasb et al. (2004), there is a lack of generally accepted and measured indicators for monitoring the progress, impacts, and performance of electricity sector reforms. Since the aim of this paper is to propose a framework for analysing the impact of the power market reforms on convergence towards the average electricity price-cost margin and on cross-subsidy levels between consumer groups, we face with the same problem. That is, we need to, first, evaluate possible impact of reforms on convergence towards the average price-cost margin *and* on cross-subsidy levels between consumer groups; second, decide which indicators to use in our study and; finally, specify methods to measure them. Let me focus on these tasks one by one.

First of all, an accurate study of reform requires an analysis of its impact on the variables we are interested in. As suggested by Jamasb et al. (2004), the expected direction of price changes as a result of reforms in developed and developing countries are often different. In many developing countries, residential customers are subsidised by industrial users while the reverse holds in some developed countries. Consequently, the expected direction of price changes from reform depends on the starting point. By introducing cost-reflective pricing, improving efficiency (and, thereby, reducing costs) in the sector; however, the reforms are expected not only to make electricity price-cost margins converge towards the average but also to reduce cross-subsidy levels between consumer groups in both developed and developing countries. Therefore, in this study, we check whether reforms really cause electricity price-cost margins to move towards the average value and cross-subsidy levels to go down.

Second, to carry out the analysis suggested above, we need to decide on the indicators to be used in the study. Since we are interested in the impact of the power market reforms on convergence towards the average electricity price-cost margin and on cross-subsidy levels between consumer groups, we need three main variables: (i) a variable representing the convergence towards average electricity price-cost margin, (ii) another variable for cross-subsidy levels between consumer groups, (iii) a third variable showing the scale and intensity of the reform. In addition to these core variables, we also utilize a set of control variables (electricity consumption, transmission and distribution losses and income level), which are assumed to be endogenous to reform process and explain a portion of the variations in both convergence towards the average electricity price-cost margin and cross-subsidy levels. However, since our focus is on the causal relationship among main variables, we do not expect or suggest a specific type of relationship concerning control variables.

Final challenge we face in this study relates to the measurement of the variables. For an indicator to be useful it needs to be based on a clear definition and to be measurable. This is equally important whether it is expressed in physical, monetary or qualitative terms. In fact, most of the economic and industry indicators (e.g. consumption, costs, prices, income level and T&D losses) are measured in some form of monetary or physical unit; and therefore, easy to include into the study. However, the extent and scope of electricity reforms are not quantifiable in physical or monetary units. The main electricity reform measures, such as privatisation, unbundling of functions, wholesale markets and independent regulation, are generally established gradually and have a qualitative dimension. Accounting for these measures with the use of dummy variables, as is sometimes done, does not reflect extent or intensity. To overcome this problem, as discussed in Jamasb et al. (2004), a practical approach has been to construct a reform index by assigning values to commonly implemented steps. In this study, we adopt this approach and form a reform indicator. The further details of variables used in this study are provided in the following section that overviews the data.

4.4.2. Econometric 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-fuel cost margins for each country and for each year; and use convergence of these margins in different countries towards their average value as dependent variable in our models. We specify convergence towards average electricity price-cost margin as a function of (i) electricity market reform score (a comparable cross-country reform indicator), (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 convergence towards average electricity price-cost margin) and (iv) other unobserved variables that influence convergence towards average electricity price-cost margin. These variables are then used in panel regressions to assess their impact on convergence towards average electricity price-cost margin. 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-fuel cost margin in a specific country and year may be influenced by electricity consumption, income level and transmission & distribution losses. In our model, we include all these variables in order to isolate the effect of the reform on convergence towards average electricity price-cost margin. Besides, prices for industrial consumers are usually supposed to be more cost-reflective than prices for households. Hence, in our analysis, we make a distinction between industrial and residential electricity prices. In addition, 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 price-cost margins, we also look at the impact of power market reforms on cross-subsidy levels.

We formulate regression equations as below to analyze the impact of electricity industry reform on convergence towards average electricity price-cost margin and cross-subsidy levels between consumer groups.

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

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 variable and control variables. Y_{it} is dependent variable (that is, convergence towards average electricity price-cost margin 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:

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

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. When we look at our dataset, we see that there are more than 90 countries in the world where a power market reform process has been initiated so far (those with a reform score of one or more) but electricity price 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 take more reform steps (that is, as the market moves further from monopoly and closer to competition), electricity price-fuel cost margins in different countries tend to move towards their average value.

Hypothesis 2. As countries introduce more and more reform steps, the cross-subsidies between industrial and residential consumers incline to decline.

Based on our hypotheses above, we expect a negative relationship between the number of reform steps taken and convergence towards average electricity price-cost margin. Similarly, we anticipate a negative relationship between the number of reform steps taken and absolute value of deviation from unit industrial/residential price ratio.

4.5. 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. Because of the missing observations, our panel is unbalanced.

The variables used in the study are electricity market reform score, convergence towards the average price-fuel cost margin for industrial/residential consumers, absolute value of deviation from unit (=1) industrial/residential price ratio, electricity consumption by industry/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.

Electricity market reform score variable takes the values from 0 to 8; depending on how many of the following reform steps have been taken in each country and each year: (1) introduction of independent power producers, (2) corporatization of state-owned enterprises, (3) law for electricity sector liberalization, (4) introduction of unbundling, (5) establishment of electricity market regulator, (6) introduction of privatization of incumbents, (7) establishment of wholesale electricity market, and (8) choice of supplier. To build this variable, we created 8 dummy variables for each of the reform steps mentioned above and calculated the total number of reform steps taken in each country and each year. Dummy variables for reform steps are created based on the data collected and cross-checked from various international and national energy regulators' web sites[4]. Since our panel dataset includes data on 63 countries for 28 years, the total number of maximum observations is 1,764 (63x28). Figure 1 provides

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

the histogram of the reform score variable showing the frequency of observations while Figure 2 presents the changes in reform score variable for the countries in our sample from 1990 to 2009.

Figure 1. Histogram of reform score variable

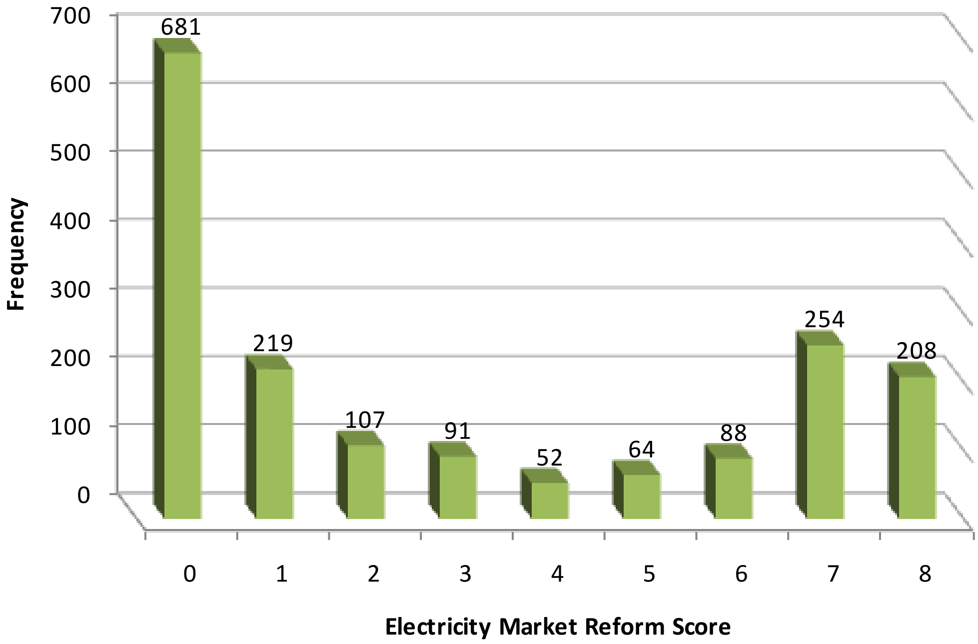
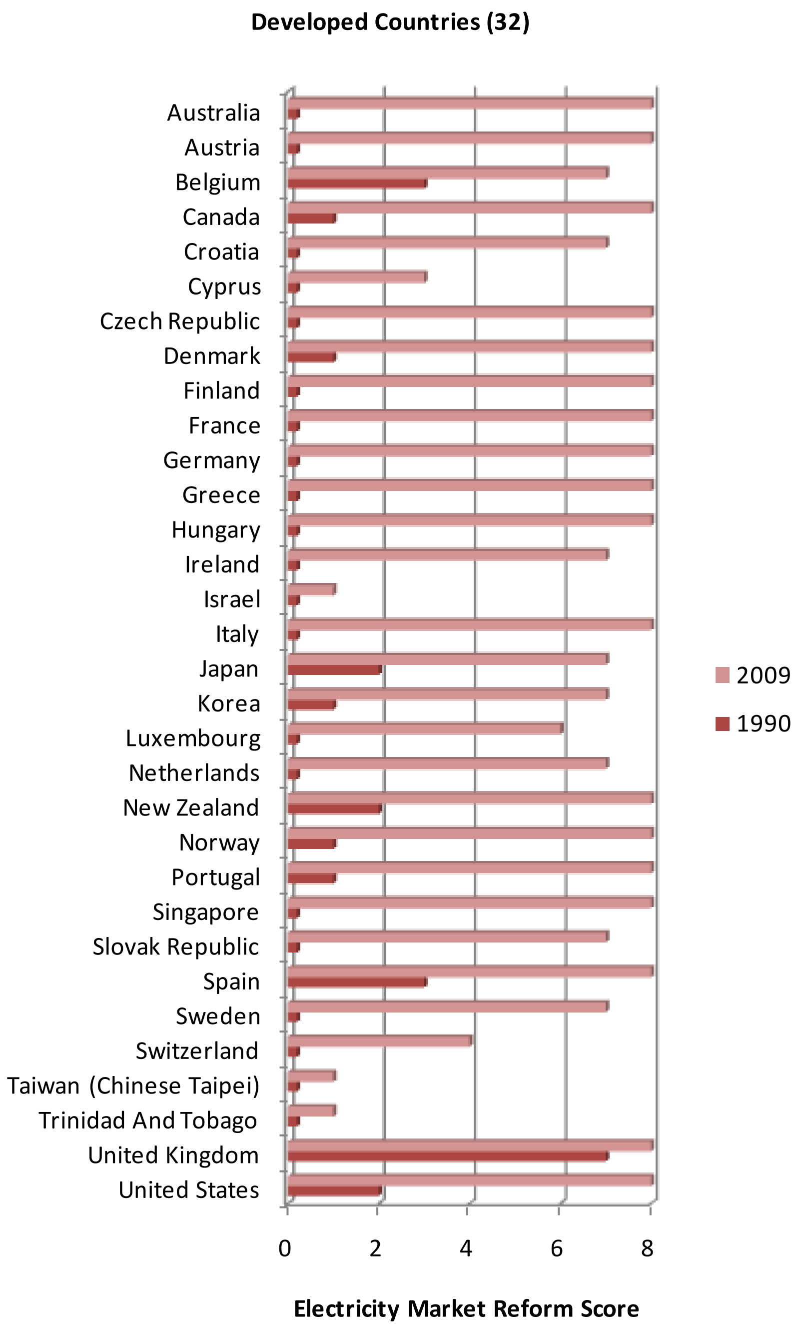
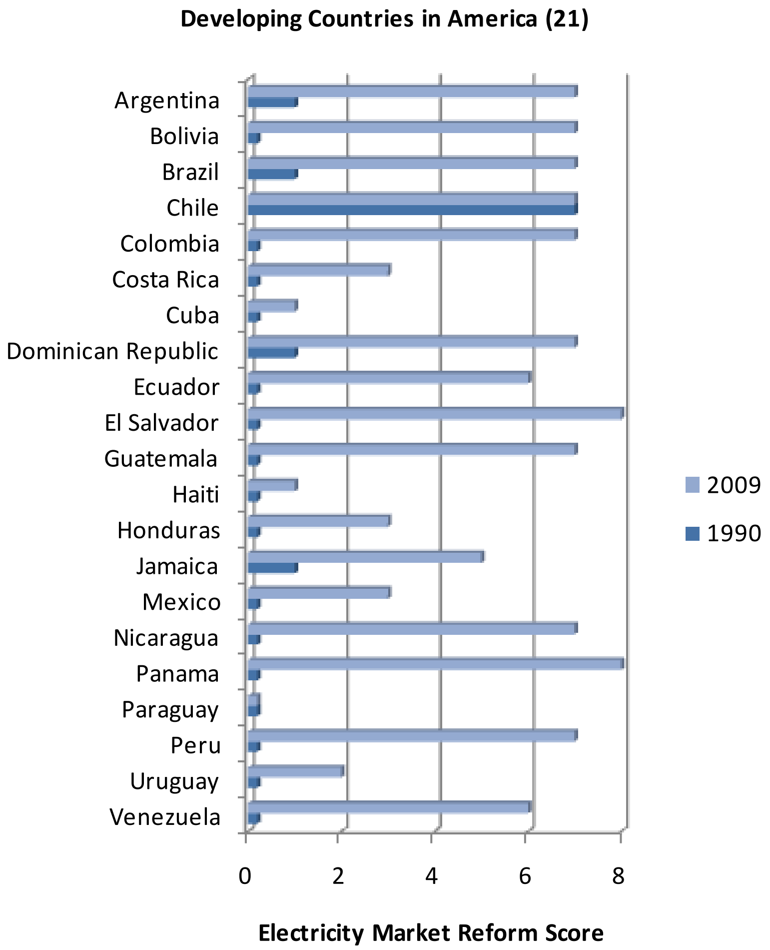
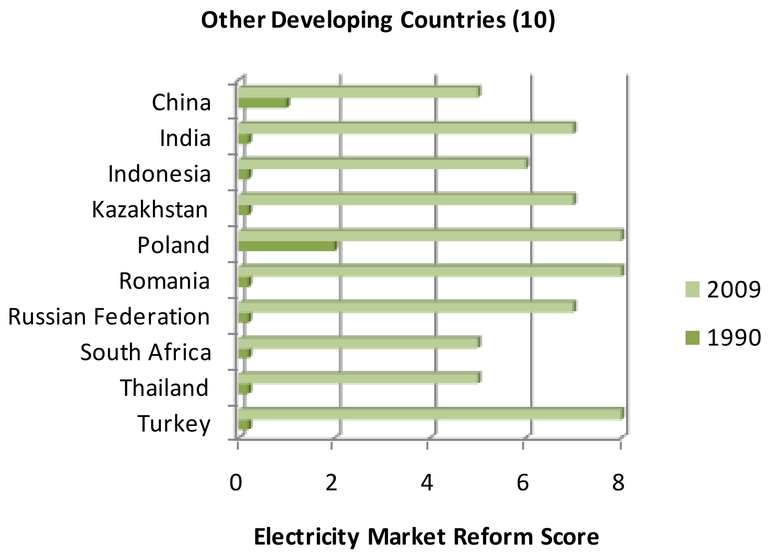


Figure 2. Electricity market reform scores of countries in the sample in 1990 and 2009







When we evaluate Figure 1 and Figure 2 together, we see that during the last two decades a lot of countries have taken many reform steps and relatively low frequency of middle range (from 2 to 6) reform scores indicates that once a country starts the reform process it proceeds very rapidly. On the other hand, the high frequency of lower range (0 and 1) reform scores implies that many countries started the reform process quite late.

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 sets of data on natural gas import costs (USD/MBtu) and coal import costs (USD/tonne) (IEA, 2010a, IEA, 2010b). 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 are 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 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-fuel 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 $\approx$ 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[5] of

[5] 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 to generate 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

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-fuel 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
- 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 3 shows the changes in price-fuel cost margins for industry and households during the last two decades in countries for which data are available.

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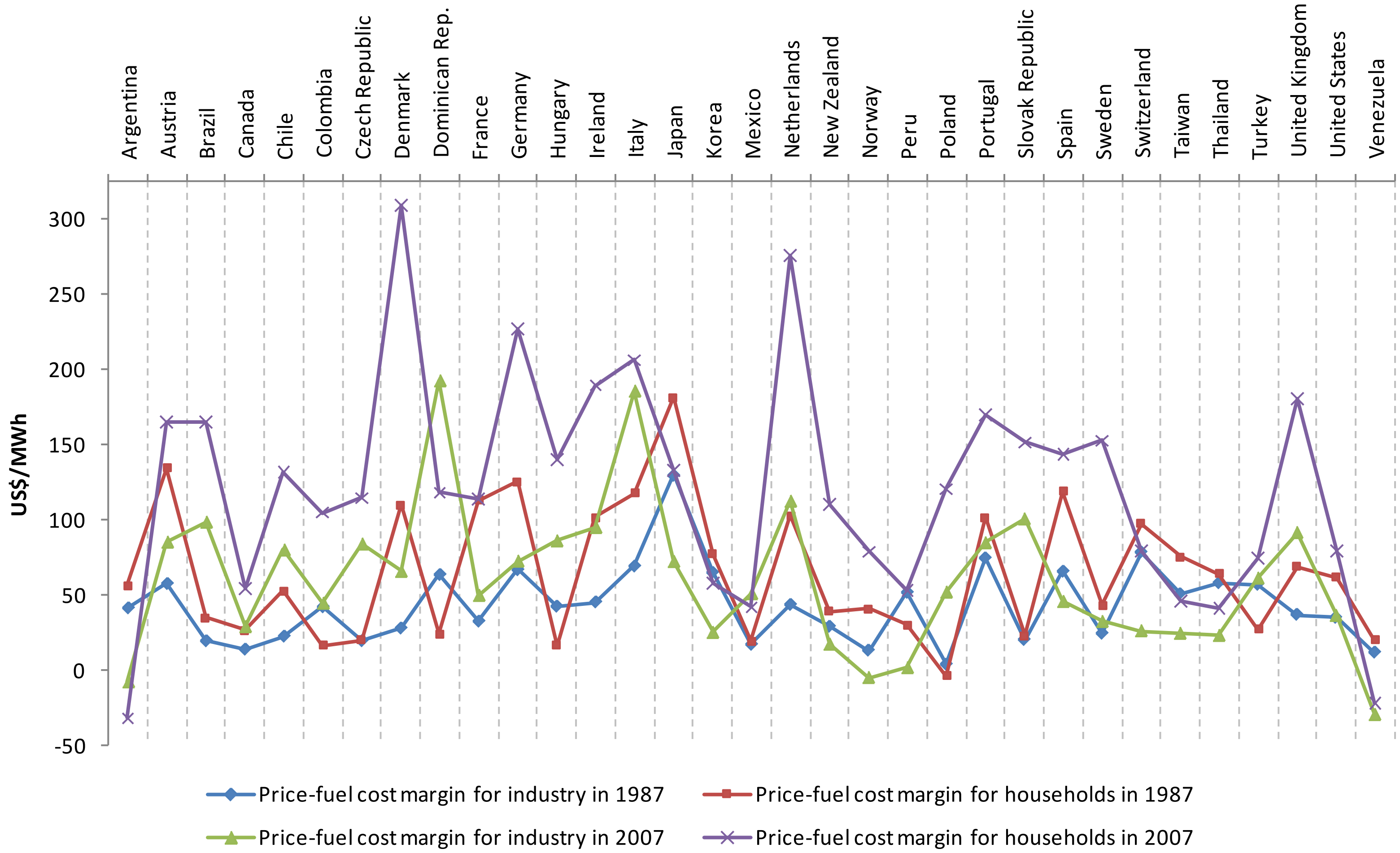
required to produce this unit of electricity. All other costs (operation and maintenance, capital and other financial costs) must be covered from the spark spread. The term **dark spread** refers to the similarly defined difference between cash streams (spread) for coal-fired power plants. In short; 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-fuel cost margin as the difference between end-user (not wholesale) electricity prices and fuel costs. Actually, price-fuel 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. 2010a. *Average Operating Heat Rate for Selected Energy Sources* [Online]. U.S. Energy Information Administration. Available: http://www.eia.doe.gov/cneaf/electricity/epa/epat5p3.html [Accessed 30.07.2010.).

Figure 3. Electricity end user price-fuel cost margins in 1987 and 2007



Following the calculation of price-cost margins for each year and each country, we created an average price cost-margin series that is composed of the averages of price cost margins for each year. Naturally, this series is different for each year but it is the same for all countries. Then, by subtracting average price-cost margin series from price-cost margin series for each country and each year and taking the absolute value of the result, we got our convergence towards the average price-fuel cost margin variable. We do not distinguish between the distance above or below the average, for that reason, we use absolute values. Of course, this variable is calculated separately for industrial and residential consumers.

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 very similar to each other 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[6] 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 2 shows descriptive statistics of the variables in our analysis.

Table 2. Descriptive statistics of the variables in the model

Variables (Units)	**# of obs.**	**# of countries**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Convergence towards the average price-fuel cost margin for industrial consumers (US$/MWh)	1,127	54	19.41	19.00	0.02	149.43

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

Convergence towards the average price-fuel cost margin for households (US$/MWh)	1,179	54	37.28	29.52	0.01	205.87
Absolute value of deviation from unit (=1) industrial/residential price ratio	1,428	61	0.39	0.27	0	2.86
Total Reform Score	1,764	63	2.95	3.15	0	8
Electricity consumption by industry sector (GWh)	1,614	63	68,257	159,064	41	1,867,656
Electricity consumption by households (GWh)	1,614	63	43,490	137,925	0	1,392,241
Electricity losses (GWh)	1,614	63	15,199	35,481	0	310,036
Proportion of loses in total supply (%)	1,614	63	11.05	7.52	0	55.87
GDP per capita (current thousand US$)	1,650	63	11.81	13.61	0.20	109.90

4.6. Empirical analysis and discussion of the preliminary results

Throughout our analysis, we estimated three groups of models to explain convergence towards the average price-fuel cost margin 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[7]. In total, we estimated 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 transformed explanatory variables (electricity consumption, electricity losses and income level variables) into logarithmic form and used these new transformed variables in our models.

[7] 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.

We perform the empirical analysis by estimating the specification given in Equation (2) for each model[8]. 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 specification to carry out our regression. Table 3 presents estimation results for each model, including estimation output, number of observations and countries included in the model estimation, results of Hausman and BPLM tests and preferred specifications based on these tests.

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

Table 3. 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	Convergence towards the average price-fuel cost margin for industrial consumers *(All countries)*	Reform score (0-8)	**0.41**	0.20	2.0	0.042	54	1,087	13.69	0.0083	-	-	Fixed Effects
		Log of electricity consumption by industry	**7.97**	2.01	4.0	0.000							
		Log of electricity losses	**-5.49**	1.83	-3.0	0.003							
		Log of GDP per capita	1.75	1.31	1.3	0.180							
		Constant	-19.18	16.81	-1.1	0.254							
Model 1.2	Convergence towards the average price-fuel cost margin for industrial consumers *(Developed countries)*	Reform score (0-8)	-0.02	0.22	-0.1	0.941	31	664	13.42	0.0094	-	-	Fixed Effects
		Log of electricity consumption by industry	-4.51	3.02	-1.5	0.136							
		Log of electricity losses	**-6.05**	2.79	-2.2	0.030							
		Log of GDP per capita	**7.96**	1.50	5.3	0.000							
		Constant	**97.05**	25.62	3.8	0.000							
Model 1.3	Convergence towards the average price-fuel cost margin for industrial consumers *(Developing countries in America)*	Reform score (0-8)	**1.82**	0.54	3.4	0.001	13	257	13.38	0.0096	-	-	Fixed Effects
		Log of electricity consumption by industry	**20.21**	3.77	5.4	0.000							
		Log of electricity losses	**-10.26**	3.63	-2.8	0.005							
		Log of GDP per capita	-4.77	3.48	-1.4	0.172							
		Constant	**-83.50**	40.52	-2.1	0.040							
Model 1.4	Convergence towards the average price-fuel cost margin for industrial consumers *(Other developing countries)*	Reform score (0-8)	**-1.15**	0.50	-2.3	0.021	10	166	4.06	0.3984	73.13	0.0000	Random Effects
		Log of electricity consumption by industry	-0.76	3.53	-0.2	0.830							
		Log of electricity losses	5.76	3.40	1.7	0.091							
		Log of GDP per capita	0.65	2.28	0.3	0.775							
		Constant	-20.47	19.37	-1.1	0.291							

Model 2.1	Convergence towards the average	Reform score (0-8)	**-1.51**	0.31	-4.9	0.000	54	1,136	25.58	0.0000	-	-	Fixed Effects
	price-fuel cost margin for	Log of electricity consumption by households	7.34	4.12	1.8	0.075							
	residential consumers	Log of electricity losses	5.35	3.42	1.6	0.118							
	(All countries)	Log of GDP per capita	**7.39**	2.20	3.4	0.001							
		Constant	**-91.31**	25.41	-3.6	0.000							
Model 2.2	Convergence towards the average	Reform score (0-8)	**-1.76**	0.36	-5.0	0.000	31	712	16.66	0.0022	-	-	Fixed Effects
	price-fuel cost margin for	Log of electricity consumption by households	**-20.24**	5.71	-3.6	0.000							
	residential consumers	Log of electricity losses	0.76	4.24	0.2	0.857							
	(Developed countries)	Log of GDP per capita	**27.12**	2.87	9.4	0.000							
		Constant	**164.93**	44.39	3.7	0.000							
Model 2.3	Convergence towards the average	Reform score (0-8)	**-1.44**	0.72	-2.0	0.047	13	257	44.91	0.0000	-	-	Fixed Effects
	price-fuel cost margin for	Log of electricity consumption by households	**32.05**	7.79	4.1	0.000							
	residential consumers	Log of electricity losses	**17.02**	6.67	2.6	0.011							
	(Developing countries in America)	Log of GDP per capita	**-29.04**	4.84	-6.0	0.000							
		Constant	**-366.98**	49.12	-7.5	0.000							
Model 2.4	Convergence towards the average	Reform score (0-8)	**-4.65**	0.69	-6.7	0.000	10	167	24.30	0.0001	-	-	Fixed Effects
	price-fuel cost margin for	Log of electricity consumption by households	**50.79**	8.17	6.2	0.000							
	residential consumers	Log of electricity losses	**-20.59**	7.46	-2.8	0.006							
	(Other developing countries)	Log of GDP per capita	-7.65	4.36	-1.8	0.081							
		Constant	**-242.35**	33.04	-7.3	0.000							
Model 3.1	Absolute value of deviation	Reform score (0-8)	**-0.01**	0.00	-4.0	0.000	61	1,364	7.80	0.0993	1121.76	0.0000	Random Effects
	from unit (=1) industrial/residential	Log of electricity consumption by industry	-0.03	0.02	-1.3	0.204							
	price ratio	Log of electricity consumption by households	**0.07**	0.03	2.6	0.010							
	(All countries)	Electricity losses in total supply (%, 0-100)	0.00	0.00	-1.4	0.163							
		Constant	0.12	0.12	1.0	0.312							

Model 3.2	Absolute value of deviation from unit (=1) industrial/residential price ratio *(Developed countries)*	Reform score (0-8)	0.00	0.00	0.6	0.558	31	687	8.88	0.0641	930.25	0.0000	Random Effects
		Log of electricity consumption by industry	-0.05	0.03	-1.6	0.116							
		Log of electricity consumption by households	**0.07**	0.03	2.5	0.014							
		Electricity losses in total supply (%, 0-100)	**-0.02**	0.00	-4.2	0.000							
		Constant	**0.31**	0.14	2.2	0.028							
Model 3.3	Absolute value of deviation from unit (=1) industrial/residential price ratio *(Developing countries in America)*	Reform score (0-8)	**-0.03**	0.01	-5.5	0.000	21	520	9.22	0.0559	155.76	0.0000	Random Effects
		Log of electricity consumption by industry	-0.01	0.04	-0.2	0.843							
		Log of electricity consumption by households	**0.08**	0.04	2.0	0.047							
		Electricity losses in total supply (%, 0-100)	0.00	0.00	0.2	0.880							
		Constant	-0.15	0.15	-1.0	0.335							
Model 3.4	Absolute value of deviation from unit (=1) industrial/residential price ratio *(Other developing countries)*	Reform score (0-8)	**-0.02**	0.01	-2.1	0.035	9	157	18.12	0.0012	-	-	Fixed Effects
		Log of electricity consumption by industry	-0.06	0.14	-0.4	0.670							
		Log of electricity consumption by households	0.08	0.13	0.6	0.540							
		Electricity losses in total supply (%, 0-100)	-0.02	0.01	-1.7	0.084							
		Constant	0.49	0.61	0.8	0.425							

Note: The coefficients that are significant at 5% level are shown in ***bold****.*

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: *convergence towards the average price-fuel cost margin for households, convergence towards the average price-fuel cost margin for industry and absolute value of deviation from unit industrial/residential price ratio*. Panel analysis of trends in these three indicators (using reform variables, country macroeconomic and other structural features) offers objective evidence on the observed impact of reforms at a macro level. Let me discuss the preliminary empirical results obtained in this study.

Apart from models explaining convergence towards the average price-fuel cost margin for industry (especially that for developing countries in America), the signs of the coefficients for electricity market reform score variables are in conformity with our expectations. First of all, the signs of the coefficients for electricity market reform score variables in Model 1.2 and Model 1.4 confirm our assumptions, meaning that reform process causes price-fuel cost margins for industry to converge towards the average value. Although the coefficient for electricity market reform score variables in Model 1.4 is statistically significant at 5% level, this is not the case for the coefficient in Model 1.2. On the other hand, the signs of the coefficients for electricity market reform score variables in Model 1.1 and 1.3 are in conflict with our assumptions and both coefficients are statistically significant at 5% level. This result implies that, especially in developing countries in America, reform process causes price-fuel cost margins for industry to move further away from the average. In all models in the second group, the relationship between reform score and convergence towards the average price-fuel cost margin seems to be both negative and statistically significant at 5% level. This result suggests that convergence towards the average price-fuel cost margin for households increases with reform process. Besides, our results suggest that there is a negative relationship between absolute value of deviation from unit (=1) industrial/residential price ratio and reform score variable, meaning that as countries (especially developing ones) take more reform steps the size of cross subsidy between these two consumer groups tends to decline. So, our empirical findings support the idea that, by removing cross-subsidies, reform process moves the industry to a more efficient state in which prices reflect the true cost of supplying electricity to consumers.

Our analysis reveals that electricity market reform score and convergence towards the average price-fuel cost margin do not have a uniform relationship for industrial users, meaning that a move from monopoly to competitive electricity market causes price-fuel cost margins in developing countries in America to move far away from the average value while it has the opposite effect in developed and other developing countries. Although we detect varying relationships between reform score and convergence towards the average price-fuel cost margin variables in the models for industrial users, this is not the case in those for households. Our study clearly shows that reform process triggers a move towards the average for residential price-fuel cost margins in both developed and developing countries.

It should also be mentioned that reform score variables have relatively weaker impact compared to other variables in 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.

Our findings point out a negative relationship between electricity consumption and convergence towards the average price-fuel cost margin in developed countries (see Models 1.2 and 2.2), implying that as electricity consumption increases price-cost margins tend to move towards the average in developed countries. On the other hand, the opposite holds true in developing countries (see Models 1.3, 2.3 and 2.4); that is, increased consumption seems to result in a move away from the average for price-cost margins in developing countries. Moreover, we found that cross-subsidy level has a negative correlation with industrial electricity consumption and a positive one with residential electricity consumption. An increase in industrial consumption seems to result in a decline in cross-subsidies while a rise in electricity consumption by households causes cross-subsidies to increase. In addition, we could not detect an explicit pattern for the impact of electricity losses and income level on convergence towards the average price-fuel cost margin and cross-subsidy levels. Finally, we see that country specific features tend to have a high power in explaining convergence towards the average price-fuel cost margin and cross-subsidy levels.

To sum up, based on our results, we reject Hypothesis 1 only for industrial consumers in developing countries in America and fail to reject it for all residential consumers and industrial consumers in developed and other developing countries. Besides, we fail to reject Hypothesis 2 for all countries and consumer groups. Overall, our results reveal that the progress toward the electricity market reform is associated with convergence towards the average price-fuel cost margin. However, although our conclusion verifies the idea that electricity market reform process (with privatisation, liberalisation and vertical disintegration) makes price-fuel cost margins in different countries converge towards their average, it does not necessarily involve a judgement on the overall success of the reform process. The convergence towards the average price-fuel cost margin 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). 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. Today, what we may argue correctly is that, as a result of reforms, price-fuel cost margins in different countries have so far tended to converge towards their average value and cross-subsidies between residential and industrial consumers have declined.

4.7. 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 too. In the context of electricity price-cost margins, it is likely that just as reform process has an effect on price-cost margins; price-cost margins can also affect reform decisions. Besides, some variables in our model may be endogenously determined. In other words, some explanatory variables in our model may influence each other, as well as the pattern of electricity price-cost margins. 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.

In econometrics, the method of instrumental variables (IV) is used to eliminate endogeneity problem. IV methods allow consistent estimation when the explanatory variables (covariates) are correlated with the error terms. Such correlation may occur when the dependent variable causes at least one of the explanatory variables (reverse causation), when there are relevant explanatory variables which are omitted from the model, or when the covariates are subject to measurement error. In such situations, ordinary regression generally produces biased and inconsistent estimates. However, if an instrument is available, consistent estimates may still be obtained. An instrument is a variable that does not itself belong in the explanatory equation and is correlated with the endogenous explanatory variables, conditional on the other covariates. In linear models, there are two main requirements for using an IV: (i) the instrument must be correlated with the endogenous explanatory variables, conditional on the other covariates, (ii) the instrument cannot be correlated with the error term in the explanatory equation; that is, the instrument cannot suffer from the same problem as the original predicting variable. In our case, for instance, it may be argued that just as electricity consumption has an effect on price-cost margins; price-cost margins can also affect power consumption levels, which may raise the issue of endogeneity. To solve the problem, we may instrument for electricity consumption using number of appliances consuming electricity (like TV, air conditions, refrigerators and so on). If the number of electrical appliances only affect electricity price-cost margins because they affect electricity consumption levels (holding other variables in the model fixed), correlation between the number of electrical appliances and electricity price-cost margins is evidence that electricity consumption causes changes in electricity price-cost margins. In addition to IV method, endogeneity may also be addressed by using lagged variables and dynamic modelling. However, since all these methods require better data we cannot employ them here. This may be, of course, an area of future research, but we have ignored these possibilities here due to lack of data.

Second shortcoming originates again 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. The main issue is that simple observation of the fact that some reform steps have been taken does not reflect their characteristics and extent (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. Accounting for these measures with the use of dummy variables does not reveal their true scope or intensity. To lessen the impact of this drawback, we did not use individual dummy variables for reform elements in this study. Instead, we constructed an aggregate reform score variable that reflects extent of the reform process. 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.

Finally, 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 problem 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. Also, a more complicated model that controls for the endogeneity might also improve estimates by better controlling for factors that affect electricity prices independently of reform process. 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.

4.8. Further development of the paper

Up to here, we have presented the progress so far in the preparation of the first paper of final PhD thesis. Although the first paper has already been improved thanks to comments from various scholars, it will be further developed in the near future. First of all, we expect to get additional data on 10-15 countries, mostly from Asia and Africa. We contacted many national statistics offices and some of them stated that they would do their best to collect and send the data as soon as possible. We expect to get additional data within a few months. Besides, we continue to work on the methodology section and will try to improve the methodology by developing a dynamic panel data framework to provide broader information on the behaviour of electricity price–cost margins and its determinants. We are especially interested in dynamic Generalized Method of Moments (DGMM) method to analyze our dataset. Finally, when we complete the final version of the first paper, it will be sent to academic journals. In the review process, the paper is expected to be further developed based on comments from referees.

4.9. 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 a few success stories (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. Within this context, this study tried to offer a macro level econometric analysis on the effects of reform process on convergence towards average electricity price-cost margin and cross-subsidy levels between consumer groups.

One of the main targets of power market reforms in the world has been price-cost margins. Throughout the study, we focused on this issue by looking at the impact of the power market reforms on the convergence of residential and industrial electricity price-cost margins in diverse countries towards their average value and on cross-subsidy levels between consumer groups. In the study, empirical econometric models with panel data from 63 countries covering the period from 1982 to 2009 were employed. We found that, in most cases, reform process causes price-cost margins in different countries to move towards their average value. Moreover, our findings confirmed that reform process makes prices more cost-reflective by reducing the size of cross subsidies between industrial and residential consumers.

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. Moreover, 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.

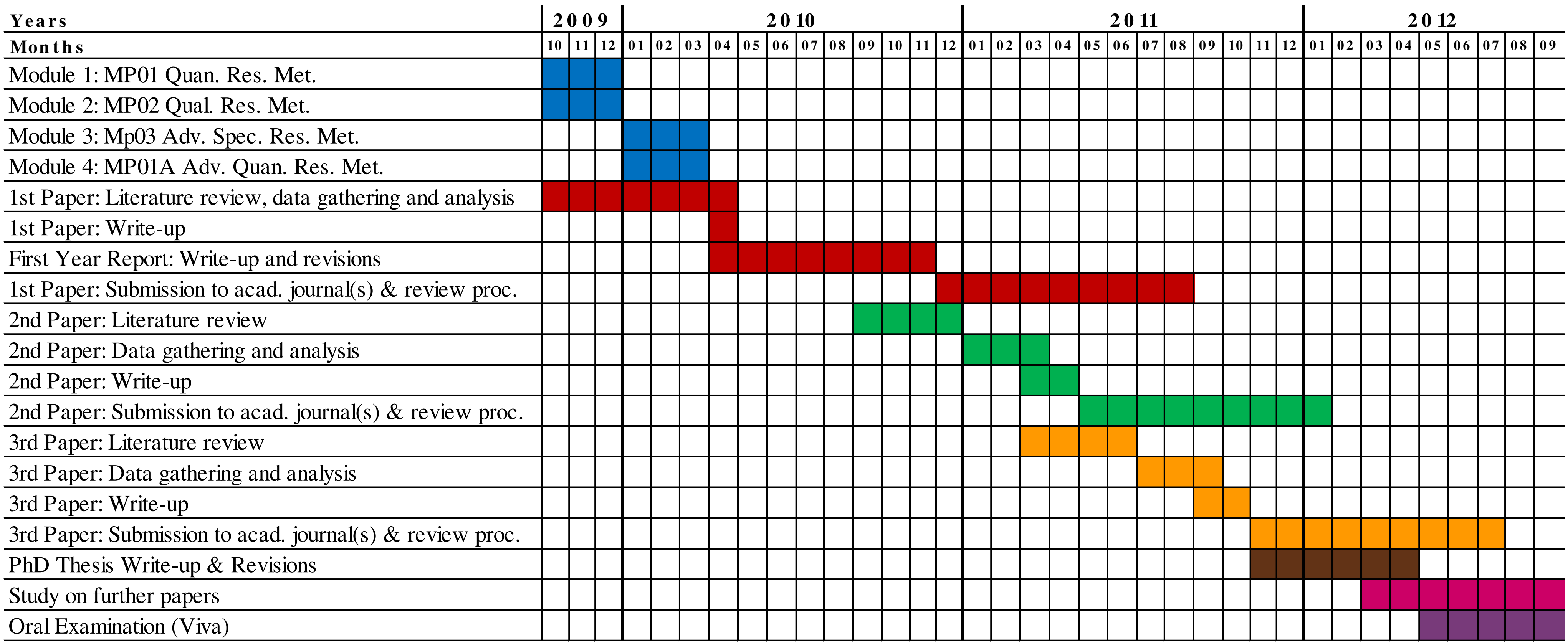
We admit that power market reform is complex and the evidence is difficult to evaluate. We also recognize that it is too early to reach any concrete judgment for future policy suggestions based on the results from this paper and other comparable studies. An exact reckoning of the long-term effects of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

5. Second & third papers and PhD research plan

Having analyzed the implications of power market reform process on the convergence towards average electricity price-cost margin and cross-subsidy levels between consumer groups, we will turn to unanswered research questions listed in Section 3 in the subsequent papers. The second paper will deal with other objectives of the reform process, especially quality of service, efficiency and investment related issues. Although we have collected most of the data for the empirical analysis in the second paper; we still need further data for a full evaluation of these issues. There is a need for additional or improved data on number of employees in electricity industries, investment levels, number and duration of power interruptions and so on. Depending on data availability, we will develop an empirical model and carry out our analysis. From the perspective of *New Institutional Economics* and related literature, the third paper is planned to focus on the institutional and qualitative aspects of the reform process and will try to find out why reforms are successful in some countries while they fail in others. Depending on the available data and results we obtain from the first three papers, we may conduct further studies.

When we make sure that we answered all research questions that we proposed to answer in this report, we will combine all papers together and prepare the final version of the PhD thesis. Submission of the thesis is planned to take place around the beginning of the 9th term in April 2012. By the time we submit final PhD thesis, we are planning to publish all three papers in respected academic journals. Our target journals include *Energy Policy* (www.elsevier.com/locate/enpol), *Energy Economics* (www.elsevier.com/locate/eneeco), *Energy Journal* (www.iaee.org), *World Bank Economic Review* (wber.oxfordjournals.org), *Applied Energy* (www.elsevier.com/locate/apenergy) and *Energy* (www.elsevier.com/ locate/energy). Last few months of the PhD process is allocated to oral examination, or viva. Table 4 presents proposed PhD research timeline.

Table 4. PhD research calendar



6. Conclusion

After more than two decades of experience with the implementation of reforms in electricity industries, it seems appropriate to move from speculation on their merits and/or drawbacks to testing their impact on empirical grounds. Proposed PhD study has focused/will focus on this issue by questioning whether competitive electricity markets result in least-cost production, appropriate quantity and quality of product, optimal pricing to consumers, and incentives for innovation. It also deals with the relationship between capabilities of the reform and expectations from it with a special focus on developing countries.

Based on experiences in a few countries, it is generally argued that where the "textbook model" has been largely followed, the reform has been broadly successful; where it has not been followed, there have been problems (Sioshansi and Pfaffenberger, 2006). However, number of studies adopting a cross-country macro approach in the evaluation of reforms is extremely limited. Proposed PhD study tries to fill this gap by providing macro level empirical analysis of power market reforms.

This report summarized the studies using econometric methods to analyze electricity market reforms. It mentioned country experiences of electricity market reforms to give the reader a flavour of what has been done so far. Then we outlined the research gap, research questions and data collection process. The main part of this report constitutes the first paper of the PhD study, titled "*The impact of power market reforms on convergence towards the average price-cost margin: a cross country panel data analysis*". The first paper showed that application of competitive market models in electricity industries makes electricity price-cost margins converge towards the average and prices more cost-reflective by reducing the size of cross subsidies between industrial and residential consumers. The second paper is expected to provide further results to evaluate the true success of reforms. As we mentioned before, it will focus on the relation between reform process and changes in quality of service, efficiency and investment in the industry.

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Appendices

Appendix 1: Description of variables in the dataset prepared for the PhD study

No	Variable Name	Unit or Range	Description	Source or Calculation Formula
v1	Identifier	1 to 2576	Observation no	-
v2	Country No	0 to 92	-	-
v3	Country Name	-	-	-
v4	Country Code	-	-	ISO 3166-1 Alpha-3 Codes
v5	Year	1982 to 2009	-	-
v6	Developing Country	0 or 1	All non-high-income countries	World Bank Country Classification
v7	Developed Country		All high-income countries	
v8	North America	0 or 1	Dummies for regions	US Energy Information Adm. Classification (http://tonto.eia.doe.gov/country, 25.02.2010)
v9	Central & South America			
v10	Europe			
v11	Eurasia			
v12	Africa			
v13	Asia & Oceania			
v14	Electricity Prices for Industry	US$/kWh	-	IEA Online Database (31.01.2010), Energy Prices and Taxes (Edition: 2009, Quarter 4), End-use Prices OLADE Online Database (28.07.2010), Energy Statistics Report
v15	Electricity Prices for Households			

v16	Ratio of Industrial to Residential Prices	-	-	v16 = v14 / v15
v17	Gross Electricity Generation	GWh	Includes electricity used by plant	IEA Online Database (20.02.2010), Electricity Information (Edition: 2009) US Energy Information Adm., Int. Energy Data and Analysis (http://www.eia.doe.gov/emeu/international, 20.02.2010)
v18	Net Electricity Generation	GWh	-	
v19	Electricity Imports	GWh	-	
v20	Electricity Exports	GWh	-	
v21	Electricity Supplied	GWh	-	
v22	T&D Losses	GWh	-	
v23	Total Electricity Consumption	GWh	-	
v24	Electricity Consumption by Industry Sector	GWh	-	

v25	Electricity Consumption by Households	GWh	-	IEA Online Database (20.02.2010), Electricity Information (Edition: 2009) US Energy Information Adm., Int. Energy Data and Analysis (http://www.eia.doe.gov/emeu/international, 20.02.2010)
v26	Electricity Consumption by Commercial and Public Services	GWh	-	
v27	Electricity Consumption by Other Sectors	GWh	-	
v28	Peak Load	MW	-	IEA Online Database (03.02.2010), OECD Net Electrical Capacity
v29	Total Electricity Installed Capacity	MW	-	US Energy Information Adm. Int. Energy Data and Analysis, (http://www.eia.doe.gov/emeu/international, 20.02.2010)
v30	Hydroelectricity Installed Capacity	MW	-	
v31	Non-Hydro Renewable Electricity Installed Capacity	MW	-	
v32	Nuclear Electricity Installed Capacity	MW	-	US Energy Information Adm. Int. Energy Data and Analysis, (http://www.eia.doe.gov/emeu/international, 20.02.2010)
v33	Thermal Electricity Installed Capacity	MW	-	

v34	Nuclear Electricity Net Generation	GWh	-	US Energy Information Adm. Int. Energy Data and Analysis, (http://www.eia.doe.gov/emeu/international, 20.02.2010)
v35	Hydroelectricity Net Generation	GWh	-	
v36	Non-Hydro Renewable Electricity Net Generation	GWh	-	
v37	Thermal Electricity Net Generation	GWh	-	
v38	Proportion of Generation From Renewable Sources	0 to 1	Includes big hydro	v38 = (v35+36) / (v34+35+v36+37)
v39	Change in Generation from Renewable Sources	GWh	Includes big hydro	$v39_t = (v35+36)_t - (v35+36)_{t-1}$
v40	Capacity Utilisation Rate	GWh/MW	-	v40 = v17 / v29
v41	Distance Between Actual and Optimal Reserve Margin	-	-	$v41 = \lvert 0.15 - [(v29 - v28)/v28] \rvert$
v42	Plant Load Factor	0 to 1	-	v42 = v17/(v29*24*365)
v43	Net Electricity Generation Per Capita	GWh / thousand people		v43 = v18 / (v76*1000)

v44	Installed Generation Capacity Per Capita	MW / thousand people		v43 = v29 / (v76*1000)
v45	Employment in Electricity Industry	thousand people	-	EU KLEMS Database November 2008 (14.02.2010), http://www.euklems.net
v46	Employment in Utility (Electricity, Gas and Water) Industries	thousand people	-	EU KLEMS Database November 2008 (14.02.2010), http://www.euklems.net Eurostat Online Database (14.02.2010), Employment by sex, age groups and economic activity (1000) UN Online Database (14.02.2010), Employment by sex and industry branch, ISIC 2 (thousands; ILO) [code 4660]
v47	Net Generation Per Employee in Electricity Industry	GWh / million people	-	v47 = v18 / (v45/1000)
v48	Net Generation Per Employee in Utility Industries	GWh / million people	-	v48 = v18 / (v46/1000)

v49	Private Investments In Electricity sector	current million US$	Data is available only for developing countries and European countries	World Bank, PPI Project Database (15.02.2010), http://ppi.worldbank.org Privatization Barometer Database (12.03.2010), http://www.privatizationbarometer.net
v50	Self-sufficiency In Electricity	-	-	v50 = v18 / v23
v51	Reserve Capacity at Maximum Demand	MW	-	v51 = v29 – v28
v52	Per Capita CO2 Emissions from Electricity Generation	kg CO2/cap	-	IEA Online Database (16.02.2010), CO2 Emissions from Fuel Combustion (Edition: 2009)
v53	Total Per Capita CO2 Emissions	kg CO2/cap	-	
v54	P->R->C	1 or 0	Dummies for the sequencing of the reforms P: Privatization R: Regulation C: Competition (Wholesale)	Collected and cross-checked by the author from various international and national web sites and papers
v55	P->C->R	1 or 0		
v56	R->P->C	1 or 0		
v57	R->C->P	1 or 0		

v58	C->P->R	1 or 0		
v59	C->R->P	1 or 0		
v60	Electricity Market Model	0, 1, 2, 3	0 - Monopoly model 1 - Single buyer 2 - Wholesale competition 3 - Retail competition	Collected and cross-checked by the author from various international and national web sites and papers
v61	Introduction of Independent Power Producers (IPPs)	1 or 0	-	Collected and cross-checked by the author from various international and national web sites and papers
v62	Introduction of Privatization	1 or 0	-	
v63	Introduction of Unbundling	1 or 0	-	Collected and cross-checked by the author from various international and national web sites and papers
v64	Establishment of Wholesale Electricity Market	1 or 0	-	
v65	Establishment of Electricity Market Regulator	1 or 0	-	
v66	Choice of Supplier (Industrial or Household)	1 or 0	-	

v67	Law for Electricity Sector Liberalization	1 or 0	-	
v68	Corporatisation of State-owned Enterprises	1 or 0	-	
v69	Total Reform Score	1 to 8	Sum of reform indicators	v69 = v61+62+v63+v64 + v65+v66+v67+v68
v70	Primary Energy Production	ktoe	-	IEA Online Database (21.02.2010), Energy Balances (Edition: 2009)
v71	Primary Energy Imports	ktoe	-	
v72	Primary Energy Exports	ktoe	-	
v73	Primary Energy Supply	ktoe	-	
v74	GDP per capita, PPP	thousand US$	-	World Bank Online Database (15.02.2010), World Development Indicators (Edition: September 2009)
v75	GDP, PPP	billion US$	-	
v76	Population	million people	-	
v77	Rate of Return on Capital in Electricity, Gas and Water Industries	-	-	EU KLEMS Database November 2008 (14.02.2010), http://www.euklems.net
v78	Energy Intensity of GDP	ktoe / billion US$	-	v78 = v73 / v75
v79	Electricity Intensity of GDP	GWh / billion US$	-	v79 = v23 / v75

v80	Third Party Access (TPA) to the Electricity Transmission Grid	1 or 0	0 - No TPA 1 - Regulated or Negotiated TPA	OECD International Regulation Database (12.03.2010), http://www.oecd.org Collected and cross-checked from various international and national web sites and papers.
v81	Legal Structure and Security of Property Rights Index	0 to 10	-	Economic Freedom of the World: 2009 Annual Report (http://www.freetheworld.com, 12.03.2010)
v82	Market Share of the Largest Generator in the Electricity Market	0 to 100	-	Eurostat Database (http://www.ec.europa.eu/eurostat, 12.03.2010)
v83	Urban Population	million people	-	World Bank Online Database (12.03.2010), World Development Indicators (Edition: September 2009)
v84	The Degree of Urbanisation	0 to 1	-	v84 = v83 / v76
v85	The Degree of Industrialisation	0 to 100	The percentage of industrial output as a share of GDP	World Bank Online Database (12.03.2010), World Development Indicators (Edition: September 09)
v86	Energy RD&D Budgets	million US$ using PPP	-	IEA Online Database (12.03.2010), RD&D Budgets
v87	Proportion of Transmission and Distribution Loses in Electricity Supplied	0 to 1	-	v87 = v22 / v21

v88	Self-sufficiency in Energy	-	-	v88 = v70 / v73
v89	Proportion of Electricity Consumption by Industry Sector in Total Electricity Consumption	0 to 1	-	v89 = v24 / (v24+v25+v26+v27)
v90	Proportion of Electricity Consumption by Households in Total Electricity Consumption	0 to 1	-	v90 = v25 / (v24+v25+v26+v27)
v91	Natural Gas Import Costs	USD/MBtu	Natural gas pipeline prices	IEA Online Database (12.05.2010), Energy Prices and Taxes (Edition: 2010, Quarter 1), Natural Gas Import Costs
v92	Coal Import Costs	USD/tonne	-	IEA Online Database (12.05.2010), Energy Prices and Taxes (Edition: 2010, Quarter 1), OECD: Coal Import Costs and Indices by Importing Country
v93	Crude Oil Import Costs	USD/bbl	Average cost of total crude imports	IEA Online Database (12.05.2010), Energy Prices and Taxes (Edition: 2010, Quarter 1), Crude Oil Import Costs
v94	Coal Import Costs	USD/Mbtu	1 MBtu ≈ 0.0359 tonne of coal equivalent	v94 = v92 / (1/0.035999396061)

v95	Crude Oil Import Costs	USD/Mbtu	1 Barrel ≈ 5.8 Mbtu	v95 = v93 / 5.8
v96	Average Fuel Cost	USD/Mbtu	Average cost of natural gas, coal and crude oil imports	Average of v91, v94, v95

Appendix 2: Batch file including model estimation steps in Stata/SE 11.1

```
************************************************************************
*                        Judge Business School                         *
*                       University of Cambridge                        *
*                        Stata batch (do) file                         *
*                      for the First Year Report                       *
*                           by Erkan Erdogdu                           *
************************************************************************

************************************************************************
*  Clear previous data, set memory, load data and specify panel data   *
************************************************************************

clear

clear matrix

set memory 100m

use "D:\JBS\FYR\FYR_RV\dataset for the revised first year report.dta"

tsset ctrno year, yearly

des c_pfm_i c_pfm_r a_rirep r_scr el_c_ind el_c_res el_loses pr_loses
gdp_pc

xtsum c_pfm_i c_pfm_r a_rirep r_scr el_c_ind el_c_res el_loses pr_loses
gdp_pc

************************************************************************
*              Transform data and generate new variables               *
************************************************************************

gen lgdp_pc = log(gdp_pc)
gen lel_c_ind = log(el_c_ind)
gen lel_c_res = log(el_c_res)
gen lel_loses = log(el_loses)

label variable lgdp_pc "Log of gdp_pc"
label variable lel_c_ind "Log of el_c_ind"
label variable lel_c_res "Log of el_c_res"
label variable lel_loses "Log of el_loses"

bro cntry if year==2009 & ctr_dved==1
bro cntry if year==2009 & dving_amr==1
bro cntry if year==2009 & dving_eaa==1

xtsum c_pfm_i c_pfm_r a_rirep r_scr lel_c_ind lel_c_res lel_loses pr_loses
lgdp_pc

************************************************************************
*          Estimation of FE and RE models and Hausman & BPLM tests     *
************************************************************************
************************************************************************
*                Model 1.1 (Overall) FE (H:0.0083)                     *
************************************************************************

xi: xtreg c_pfm_i r_scr lel_c_ind lel_loses lgdp_pc, fe

estimates store fixed
```

```
xi: xtreg c_pfm_i r_scr lel_c_ind lel_loses lgdp_pc, re

hausman fixed

**********************************************************************
*              Model 1.2 (ctr_dved) FE (H:0.0094)                    *
**********************************************************************

xi: xtreg c_pfm_i r_scr lel_c_ind lel_loses lgdp_pc if ctr_dved==1, fe

estimates store fixed

xi: xtreg c_pfm_i r_scr lel_c_ind lel_loses lgdp_pc if ctr_dved==1, re

hausman fixed

**********************************************************************
*              Model 1.3 (dving_amr) FE (H:0.0096)                   *
**********************************************************************

xi: xtreg c_pfm_i r_scr lel_c_ind lel_loses lgdp_pc if dving_amr==1, fe

estimates store fixed

xi: xtreg c_pfm_i r_scr lel_c_ind lel_loses lgdp_pc if dving_amr==1, re

hausman fixed

**********************************************************************
*              Model 1.4 (dving_eaa) RE (H:0.3984, B:0.0000)         *
**********************************************************************

xi: xtreg c_pfm_i r_scr lel_c_ind lel_loses lgdp_pc if dving_eaa==1, fe

estimates store fixed

xi: xtreg c_pfm_i r_scr lel_c_ind lel_loses lgdp_pc if dving_eaa==1, re

hausman fixed

xi: xtreg c_pfm_i r_scr lel_c_ind lel_loses lgdp_pc if dving_eaa==1, re

xttest0

**********************************************************************
*              Model 2.1 (Overall) FE (H:0.0000)                     *
**********************************************************************

xi: xtreg c_pfm_r r_scr lel_c_res lel_loses lgdp_pc, fe

estimates store fixed

xi: xtreg c_pfm_r r_scr lel_c_res lel_loses lgdp_pc, re

hausman fixed

**********************************************************************
*              Model 2.2 (ctr_dved) FE (H:0.0022)                    *
**********************************************************************
```

```
xi: xtreg c_pfm_r r_scr lel_c_res lel_loses lgdp_pc if ctr_dved==1, fe

estimates store fixed

xi: xtreg c_pfm_r r_scr lel_c_res lel_loses lgdp_pc if ctr_dved==1, re

hausman fixed

************************************************************************
*               Model 2.3 (dving_amr) FE (H:0.0000)                     *
************************************************************************

xi: xtreg c_pfm_r r_scr lel_c_res lel_loses lgdp_pc if dving_amr==1, fe

estimates store fixed

xi: xtreg c_pfm_r r_scr lel_c_res lel_loses lgdp_pc if dving_amr==1, re

hausman fixed

************************************************************************
*               Model 2.4 (dving_eaa) FE (H:0.0001)                    *
************************************************************************

xi: xtreg c_pfm_r r_scr lel_c_res lel_loses lgdp_pc if dving_eaa==1, fe

estimates store fixed

xi: xtreg c_pfm_r r_scr lel_c_res lel_loses lgdp_pc if dving_eaa==1, re

hausman fixed

************************************************************************
*               Model 3.1 (Overall) RE (H:0.0993, B:0.0000)            *
************************************************************************

xi: xtreg a_rirep r_scr lel_c_ind lel_c_res pr_loses, fe

estimates store fixed

xi: xtreg a_rirep r_scr lel_c_ind lel_c_res pr_loses, re

hausman fixed

xi: xtreg a_rirep r_scr lel_c_ind lel_c_res pr_loses, re

xttest0

************************************************************************
*               Model 3.2 (ctr_dved) RE (H:0.0641, B:0.0000)           *
************************************************************************

xi: xtreg a_rirep r_scr lel_c_ind lel_c_res pr_loses if ctr_dved==1, fe

estimates store fixed

xi: xtreg a_rirep r_scr lel_c_ind lel_c_res pr_loses if ctr_dved==1, re

hausman fixed

xi: xtreg a_rirep r_scr lel_c_ind lel_c_res pr_loses if ctr_dved==1, re
```

```
xttest0

**********************************************************************
*               Model 3.3 (dving_amr) RE (H:0.0559, B:0.0000)        *
**********************************************************************

xi: xtreg a_rirep r_scr lel_c_ind lel_c_res pr_loses if dving_amr==1, fe

estimates store fixed

xi: xtreg a_rirep r_scr lel_c_ind lel_c_res pr_loses if dving_amr==1, re

hausman fixed

xi: xtreg a_rirep r_scr lel_c_ind lel_c_res pr_loses if dving_amr==1, re

xttest0

**********************************************************************
*               Model 3.4 (dving_eaa) FE (H:0.0012)                  *
**********************************************************************

xi: xtreg a_rirep r_scr lel_c_ind lel_c_res pr_loses if dving_eaa==1, fe

estimates store fixed

xi: xtreg a_rirep r_scr lel_c_ind lel_c_res pr_loses if dving_eaa==1, re

hausman fixed

**********************************************************************
*                            End of do file                          *
**********************************************************************
```