



# New evidence on the impact of structural reforms on electricity sector performance



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## HIGHLIGHTS

- We assess the impact of structural reforms on OECD electricity sector performance.
- Regulation has stronger impact on performance when interaction terms are present.
- Privatisation has unambiguous effect on the elements of performance.
- The combined effect of reforms on performance is more aggressive in the long run.

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## ABSTRACT

The evolution of electricity industry over the last decades has shown substantial differences between OECD countries. This paper empirically investigates to what extent different structural forms of regulation, competition and privatisation explain these international differences. It distinguishes three modes of electricity performance: a) net generation per capita, b) installed capacity and c) labour productivity. The empirical model spans the period 1975–2011 and uses panel data econometric techniques. Our analysis reveals that there is a strongly significant interaction impact on the level of electricity performance between regulation and competition. The empirical findings do confirm that a robust independent regulatory scheme must be implemented in order to achieve a competitive electricity market.

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## 1. Introduction

After prolonged periods of structural immobility in the electricity industry, during the past two-and-a-half decades, governments have been allowing market forces to play an increasing role in the sector. Indeed, in recent years, structural change in the electricity industry became a global phenomenon (Pollitt, 2009; Fafaliou and Polemis, 2010). A large number of countries have introduced a combination of institutional reforms (i.e. competitive restructuring, regulatory reform, creation of regulatory institutions, and privatisation, etc). It has been difficult so far to get a clear picture of reform results for various reasons. First, countries have implemented electricity sector reforms in varying ways and

degrees. Second, crucial economic variables are marred by severe measurement problems, especially in developing and transition economies and lastly privatisation and regulatory reform have usually been implemented simultaneously making it very difficult to quantify their separate effects.

This paper investigates to what extent structural reforms affect electricity sector performance for 30 OECD countries over the period 1975–2011. In particular, using two different econometric methodologies for panel data, such as a static fixed effects procedure and a dynamic GMM approach, employed by Arellano and Bond (1991), this study aims to identify the effects of regulation, competition and privatisation on the performance of the industry. Unlike previous studies, this research tries to explore the difference between separate and joint effects among these structural reform variables, in the concept of a static model as well as the

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difference between short run and long run effects in the concept of a dynamic model. The objective is to capture the separate effects that these main drivers of electricity performance have for OECD countries as well as how they contribute to the design of better regulatory reform programs.

This paper contributes the literature in many ways. Firstly, unlike previous studies (Zhang et al., 2002; Cubbin and Stern, 2006; Zhang et al., 2008; Erdogdu, 2011), devoted on this topic we try to assess the linkage and the possible spillover effects between regulation, competition and privatisation and the level of electricity performance by using superior measures of the effectiveness of regulation and competition. For this reason, we use the most up to date regulation and competition indices provided by the OECD. Secondly, this is the first study we use the regulation components of the Fraser Index of Economic Freedom to examine the impact of credit (financial), labour and business regulation, on electricity performance in the 30 OECD sample countries. The use of the FRASER index, allows greater insight into this issue and this is one of the novelties of this paper. Thirdly, it goes beyond the existing literature in that it combines static and dynamic panel data econometric techniques, in which rather scant attention has been paid by the earlier studies (Fiorio et al., 2007; Zhang et al., 2008). It is worth mentioning that the combined use of static and dynamic interactions between the variables of our models will also test for the robustness of our findings.

The rest of the paper is organized as follows. Section 2 reviews the empirical literature, while Section 3 presents the methodology used in the empirical analysis. Section 4 reports the main empirical findings of the paper. Lastly, Section 5 concludes the paper and provides some policy implications.

## 2. Review of the literature

From the empirical stand point, it is interesting to highlight that many researchers have attempted to study and analyse several aspects of the electricity sector. At the macroeconomic level an effort is made to examine economic growth with respect to the level of electricity intensity, including issues of causality (see, for example, Hondroyannis et al., 2002; Narayan and Smyth, 2007; Lee and Chang, 2008; Payne, 2010; Ozturk, 2010; Tang and Tan, 2012; Polemis and Dagoumas, 2013). Some other researchers have analysed micro-economics aspects of the electricity sector mainly by estimating price elasticities among other things (Maddala et al., 1997; Bernstein and Graffin, 2005; Polemis, 2006, 2007; Fell et al., 2014). Beyond of all these perspectives, several other studies have investigated the impact of structural reform policies regarding regulation, competition and privatisation on the overall performance of the electricity sector.

Earlier studies highlight the importance of political and institutional variables (i.e level of taxation, FDI influx, corruption in the public sector, etc) in determining the pace of reform and the investment activity in the electricity industry (see for example Henisz, 2000; Bacon and Besant-Jones, 2001). Most of these studies use panel data econometric methodology (fixed effects and GMM estimators) and focus on the developing countries while others examine the impact of these indicators on more liberalised regimes (i.e European countries).

We must stress however, that the majority of the empirical studies are devoted in the assessment of the effect of structural reform variables such as regulation, competition and privatisation on the level of electricity performance. Two pioneering studies consent that effective regulation followed by the opening of the markets to competition increases electricity performance (Bortolotti, et al., 1998; Steiner, 2001). This empirical finding can also be confirmed by more recent studies (see for example Zhang et al., 2002, 2005; Cubbin and Stern, 2006; Fiorio et al. 2007; Zhang et al., 2008, Erdogdu, 2011;

Pompei, 2013). In a recent interesting study, Davis and Wolfram (2012) examine the effects of deregulation on the US nuclear electricity generation industry, and critically discuss the interaction between privatisation and regulation. More specifically, they analyse operating efficiency before, during, and after market restructuring and conclude that deregulation and consolidation are associated with a 10% increase in operating efficiency. These results provide clear evidence of efficiency gains from the deregulation of electricity markets since removing regulation has provided incentives for firms to increase efficiency, reduce costly outages, and make prudent investments in capacity.

All of these studies use a variety of indicators (i.e dummy variables, constructed indices) in order to quantify the level of structural reforms in the electricity industry. However, they neglect to account for the effect of these reforms on the level of prices in the sector. This gap has been filled within the last decade by some empirical studies (Hattori and Tsutsui, 2004; Fiorio and Florio, 2013). Specifically, Hattori and Tsutsui (2004), find that expanded retail access is likely to lower the industrial price and increase the price differential between industrial customers and household customers. They also claim that the unbundling of generation and the introduction of a wholesale spot market did not necessarily lower the price and may possibly have resulted in a higher price. Similarly, Fiorio and Florio (2013), assess the impact of corporate ownership on residential net-of-tax electricity prices, when the ownership effect is separated from the liberalisation effect and from other drivers of change. They use IEA and OECD data for the EU-15 over nearly three decades. Panel econometrics suggests that, after controlling for other factors, public ownership is associated with lower residential net-of-tax electricity prices in Western Europe. However, the impact of liberalisation on prices is smaller and more uncertain.

In contrast to the related studies, that use partial equilibrium models, Akkemik and Oguz (2011) make use of applied computable general equilibrium model in order to examine the competitive conditions in the Turkish electricity industry. They argue that regulatory reforms have led to the enhanced efficiency in the electricity sector, reduced household energy prices, and gains in output and welfare. Moreover, with changing institutional background and legal framework, political pressures tend to dominate efficiency gains.

Overall, the available empirical evidence suggests that in assessing the results of electricity privatisation in various countries the effects of competition and regulation also need to be taken into account. However, the empirical literature is still in its infancy since most of the reported studies have tended to look at only one or maybe two of these three reforms without controlling for the others neglecting possible interaction effects. Further, one of the main weaknesses of the empirical studies on this issue is that serious problems related to measurement and specification choice have not permitted a definitive and defensible structural interpretation of results. The absence of tight specification along with the existence of competing structural explanations for the findings of most of these studies is a reason why this line of research has not been able to provide a convincing assessment of the electricity reform outcomes.

## 3. Data and methodology

We use an unbalanced panel data set for 30 OECD countries over the period from 1975 to 2011.<sup>1</sup> The model employed in this

<sup>1</sup> The sample countries are the following: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, Turkey, United Kingdom and the United States.

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