



Heterogeneous effects of regulation on the efficiency of the electricity industry across European Union countries



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ABSTRACT

This paper focuses on the relationship between the stringency of regulation (OECD indicators) and total factor productivity (TFP) growth in the electricity sectors of 19 European Union countries for the period 1994–2007. Both the OECD regulatory indicator and the TFP growth index have been decomposed in order to bring to light a complex picture of interrelations in which the negative impact of the overall regulation on productivity is the result of opposite forces. Estimation results tell us that only the stringency of entry regulation significantly reduces technological change, whereas vertical integration exhibits a negative and significant impact only on the catching up process (pure efficiency change). Lastly, we found an interesting result concerning the explanatory variables of the scale efficiency change: in this case only public ownership matters, in other terms high levels of public in the structure ownership of electric companies guarantee improvements in reaching the optimal scale of production. These heterogeneous effects are also confirmed when we use a different measure of efficiency, that is, the distance of the actual from the optimal reserve margin.

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1. Introduction

Restructuring, liberalising and privatising the electricity sector in developed and developing countries have resulted from a common view of economic policy that has dominated over the last two decades. In the European Union (EU), the experience of the United Kingdom as a trail-blazer of liberalisation in the industry stimulated the adoption of three electricity directives (European Commission: 1996/92; 2003/54 and 2009/72) that gradually addressed different aspects of liberalisation but maintained the same long-term overriding goal of transforming individual state-owned monopolies into a single competitive EU electricity market (Haas et al., 2006; Jamasb and Pollitt, 2005; Joskow, 2008; Littlechild, 2006). Pollitt (2009) recently acknowledged this effort as a formidable pro-competitive reform programme, although he also noted that the provisions did not explicitly address the issue of privatisation, as very few countries thus far have fully private electric companies (only the United Kingdom and Germany through 2007). Indeed, European Union reforms emphasise unbundling networks from generation and retailing, reducing collusion among large companies, eliminating entry barriers, guaranteeing an independent regulatory authority and ensuring the adequacy of supply. Consequently, many studies have focused on post-reform performance of electricity sectors around the world and within the European Union. Most of these studies have concerned the price and welfare effects of liberalisation, focusing

on one or a handful of countries. Often, the reason for limiting analysis to just a few countries was to avoid the distortions that arise in large cross-country price-effect assessments. For example, some authors perceptively observed that the lack of information regarding different fuel cost regimes could lead to meaningless cross-country comparisons of electricity prices before and after the reforms (Harvey et al., 2006; Joskow, 2006b). The few remaining studies contain large cross-country comparisons based on physical measures of efficiency, with the European Union countries included as a small group along with other developed, emerging and less developed countries. It thus appears that updated cross-country comparisons are lacking, especially studies that address the effects of reforms on the technical efficiency of the generation sector in the European Union.

This paper aims to fill this gap and contribute to the debate on the effects of the pro-competitive reforms. Indeed, we find that less regulation produces some general benefits but also some contradictory effects with respect to specific aspects of technical efficiency. The study focuses on the relationship between regulation levels (OECD indicators) and total factor productivity (TFP) growth in the electricity generation sectors of 19 European Union countries during the 1994–2007 period. Both the OECD regulatory indicator and the TFP growth index are decomposed to illustrate the complex interrelations between regulation and productivity growth. Specifically, we find that high entry barriers and vertical integration negatively affect only technological change and pure efficiency change (catching up), respectively, whereas increased public ownership is found to cause significant changes in scale efficiency.

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To test the robustness of these results, another proxy for efficiency is used. The distance between the actual and the optimal reserve margin (reserve margin deviation) in the electric power industry is often viewed as a measure of correctly planned electricity supply, that is, supply that satisfies demand without excessively reducing or enlarging the buffer (Erdogdu, 2011; Steiner, 2001). This indicator thus provides useful information. In particular, it enables us to obtain complementary evidence, as TFP improvement due to the increasing utilisation of the installed capacity (that is the capital productivity) can be achieved at the cost of an insecure supply of electricity, that is, an excessive reduction in the margin between existing capacity and peak demand. The econometric analysis below shows a very weak negative effect of the overall regulation index on efficiency. Indeed, this general result is only supported by the negative effect of higher vertical integration on the reserve margin deviation, whereas neither entry barriers nor public ownership are found to have significant effects.

Our results appear to complement evidence presented in recent literature. For example, Fiorio and Florio (2011) study a similar set of European Union countries, focusing on different aspects of liberalisation and privatisation, combined with subjective data, and find that only liberalisation (lower entry barriers) increases the probability of consumer satisfaction with electricity prices, whereas privatisation (reduced public ownership) has the opposite effect. Similarly, in the present paper, the same dimensions of regulation are found to work in the same directions with respect to technical efficiency and the reserve margin deviation. Thus, structural motivations involving the supply side of the electricity sector are consistent with existing evidence on consumer and welfare effects.

At a more general level, by implementing a two-stage approach in a cross-country analysis and clarifying the different effects of liberalisation and privatisation, this paper addresses scholars and policy makers across the European Union. Indeed, the advice proffered is to disclose and typify the different dimensions of the overall market reforms of the electricity sector to separately evaluate their real effects on efficiency.

The remainder of the paper is organised as follows. A literature review is presented and the conceptual bases of this study are discussed in Section 2. Section 3 covers the first stage of the analysis. In this section, we present data sources, descriptive statistics and estimations of the Malmquist index of TFP. The second stage of the analysis, that is, evaluation of the impact of regulation on TFP growth and on the reserve margin deviation in the electricity sector, is treated in Section 4. Finally, some concluding remarks are presented in Section 5.

2. Theoretical background and strategy of the empirical analysis

An exhaustive review of the vast literature on the post-reform performance of the electricity sector is beyond the scope of this paper.¹ Therefore, we will limit our discussion to recent studies focused on physical measures of efficiency and/or OECD regulatory indicators. This decision is motivated by two key considerations underlying cross-country comparisons, considerations that give rise to one of the most important approaches to the effects of liberalisation (Joskow, 2006a, 2008). The first consideration, already noted above, concerns the use of physical measures of performance in the electricity sector to avoid distortions that arise in cross-country price-effect assessments. The second consideration concerns the need to harmonise indicators of regulation in between-country econometric analyses. In this field, the indicator of regulation in the electricity sector, stemming from the vast methodological study on product market regulation (PMR) in OECD countries, appears to be the most suitable (Conway and Nicoletti, 2006; Wölfl et al., 2009).

In view of these considerations, it is worth noting the survey of Steiner (2001), who analyses the effect of the first wave of reforms (1986–1996 period) on 19 OECD countries, of which 13 are European Union countries. Apart from electricity prices, he considers physical measures of efficiency in electricity generation, for example, the capacity utilisation rate and the distance of the actual from the optimal reserve margin. He also constructs 8 harmonised regulatory indicators based on an ad hoc OECD questionnaire, finding that privatisation and vertical separation of generation from transmission companies has a positive effect on technical efficiency. Fiorio et al. (2007) focus on the EU-15 countries, studying a longer period, 1975 to 2005. Although these authors consider only the retail price of electricity for households as a measure of performance, they use the regulatory indicator and its three sub-components developed by the PMR research programme of the OECD. This study is of interest because the results are not univocal: only the stringency of entry regulations is found to raise electricity prices, whereas the levels of public ownership and vertical integration play no role in price levels. Similarly, in a more recent paper (Erdogdu, 2011)—in which net electricity generation per employee is used as an efficiency measure, as well as the transmission losses on total power generated and the distance of actual from the optimal reserve margin—the results are not univocal. Indeed, the author includes in his empirical investigation 92 economies, of which 21 are EU countries, for the 1982–2008 period. He finds that his own calculated electricity market reform scores have a positive impact on labour productivity, a nonlinear influence on the reserve margin deviation (that is, beyond a given threshold, deregulation enlarges the deviation) and, at the same time, undesired effects that increase average electricity losses. Similarly, Zhang et al. (2008) estimate the impact of electricity market reforms on electricity generation per employee in 36 developing and transitional economies for the 1985–2003 period. They find that only increasing competition has a positive impact on labour productivity, whereas privatisation and other deregulatory reforms do not.

Other studies are also worth noting, as they use refined indices of technical productivity, such as the Malmquist index of TFP (Abbott, 2006; Estache et al., 2008; Hattori et al., 2005; Nakano and Managi, 2008; Pérez-Reyes and Tovar, 2009; Ramos-Real et al., 2009). Although these are almost all company level analyses focused on the electricity distribution segment and relying on within-country or at most two-country comparisons, their methodological approach is of interest. First, these researchers, by relying on non-parametric methods such as Data Envelopment Analysis (DEA), decompose the overall TFP growth rate into three components: i) technological change, ii) pure efficiency change and iii) scale efficiency change. In so doing, they obtain a more complex picture of the effects of reforms on TFP change. In particular, two such studies use a two-stage approach: 1) a non-parametric estimation (DEA method) of the TFP growth rate and its components in the first step; 2) econometric analysis in which they regress output from the first step on regulation indicators in the second step. Utilising this strategy, Nakano and Managi (2008) find for Japanese companies a positive impact of liberalisation only on technological change but not on efficiency change. Similarly, Pérez-Reyes and Tovar (2009), focusing on Peruvian distribution companies, find that while privatisation sharply improves the frontier shift (technological change), it has more modest effects on pure and scale efficiency changes.

The present paper moves towards the methodological approach proposed by Nakano and Managi (2008) and Pérez-Reyes and Tovar (2009). Thus, first, the TFP growth rate, as measured by net electricity generation for 19 EU countries between 1994 and 2007, is estimated, and the overall TFP change is decomposed into the frontier shift (technological change), catching up (pure efficiency change) and movements toward the optimal scale of production (scale efficiency). Second, these technical efficiency indices are regressed on the OECD regulatory indicator for the electricity sector, which in turn is decomposed

¹ Comprehensive reviews are found in Sioshansi and Pfaffenberger (2006) and Joskow (2008).

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