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Competition, Regulation and Privatisation of Electricity Generation in Developing Countries: Does the Sequencing of the Reforms Matter?

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Abstract

Recent years have seen countries introducing reform of their utility industries with a view to promoting private ownership and competition. This paper studies the effect of the sequencing of privatisation, competition and regulation reforms in electricity generation using data from 25 developing countries for the period 1985 to 2001. A fixed effects panel data model is used. The study finds 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.

Key words: privatisation, competition, regulation, developing economies, economic performance.

JEL classification: L33; L43; L44; L50; 012; O38; O50

1. Introduction

Spurred by political, technological and institutional changes, countries around the world have undertaken reform and restructuring in their infrastructure industries over the last two decades. Privatisation and regulatory reform have been adopted as the solution to the problem of poor performance by formerly state-owned incumbents, and as the means to achieve improved services and lower prices. In order to stimulate allocative and productive efficiency, competition has been introduced to activities where the notion of 'natural monopoly' has been rejected. While it may be the case that each of the reforms – privatisation, regulation and competition – is desirable (Vickers and Yarrow, 1988; Martin and Parker, 1997; Parker and Kirkpatrick, 2005), there is rarely a country that has felt able to introduce all three measures simultaneously. An important question for policy, therefore is whether there is an optimal sequencing of the reforms. For example, should privatisation occur before or after the establishment of a regulatory system or before or after the introduction of competition?

Sitiglitz (2002, p.18) writes in relation to economic development that 'successful economic programs require extreme care in *sequencing* – the order in which reforms occur' (emphasis in the original).The issue of reform sequencing in developing countries has been extensively debated in the context of both trade and financial liberalisation. The concentration of structural adjustment programmes on trade liberalisation fostered considerable discussion of the optimal sequencing of tariff reductions and the removal of quota protection measures in affecting the impact of liberalisation on economic performance (Kirkpatrick 1995; Kirkpatrick and Weiss,

1995). In the 1990s the premature liberalisation of international capital movements in the context of a weak domestic financial regulatory framework was a major contributory factor in the financial crises that affected many Asian and other developing countries in the latter half of the decade (Brownbridge and Kirkpatrick, 1999, 2000).

In contrast, debate on the sequencing of privatisation and regulation has been confined until recently, to the transitional economies of Central and Eastern Europe. Reform sequencing has been debated from the late 1980s when the former communist countries began their transition to market economies. Fast and large-scale privatisation programmes were adopted by a number of these countries but often appeared to fail to produce the intended results in terms of quick economic performance improvement (Filatotchev, 2003; Hare and Muravyev, 2003). Researchers (e.g. Fershtman, 1989; Dewatripont and Roland, 1992; Roland, 1994; Hirschhausen and Opitz, 2001) then argued for gradualism, which emphasised the importance of first establishing institutional infrastructures conducive to market exchange, including competitive industrial structures and appropriate regulatory systems. This debate was mirrored in the 1990s by growing evidence from the industrialised Western economies, including the UK, that privatisation alone was insufficient to stimulate performance improvement, especially in the public utilities with their natural monopoly characteristics (e.g. Martin and Parker, 1997).

In spite of the perceived importance of managing the reform process effectively and paying attention to the establishment of competition and regulation, there remains a paucity of study of the appropriate sequencing of reforms in utility sectors in

developing economies. The only studies that have looked at this issue in detail are based on data from telecommunications (Wallsten, 2002; Fink et al., 2002), the sector where the wave of reform first began and has been the most extensive. No econometric work appears to have been undertaken to test the effects of reform sequencing in the electricity power sector. This is probably because of a lack of consistent data for this sector (compared to telecommunications where the International Telecommunications Union and now the World Bank in conjunction with Stanford University have collected considerable data) and partly because of the difficulty in accurately assessing the various reforms adopted by different countries. In this paper we attempt to address this gap in knowledge by testing for the effects of sequencing between privatisation, competition and regulation in the electricity-generation sector. Based on a panel dataset covering 25 developing countries for the period 1985 to 2001, this study finds 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 between privatisation and competition, improved capital utilisation. An earlier paper (Zhang et al., 2002) used a larger data set involving 51 developing countries over the period from 1985 to 2000. This study found that competition was more important than privatisation in raising economic performance in electricity generation, but did not consider the role of sequencing. The current paper uses a subset of this data to test for sequencing effects with the data cross-checked against information published on the World Bank's web site, where there are overlaps.[1] This means that the research focuses on those countries where reforms to their electricity sector have occurred and the necessary data are available on privatisation, competition and regulation. This

[1] World Bank (2004a), Electricity Regulation Database,

may admittedly introduce some sample bias because the countries included are likely to be those that have introduced some of the most significant reforms to their electricity sectors. The results might not hold for other countries. Also, no developed economies are included in the data set and future research is needed to assess whether our results are robust across economies at different levels of development.

The paper is organised as follows. Section 2 presents background information on electricity reform. Section 3 provides a review of relevant empirical and theoretical studies on competition, regulation and privatisation, from which the research hypotheses are developed. Data issues and modelling are presented in Section 4. The following section discusses the results and Section 6 provides concluding remarks.

2. Background

Network infrastructure industries have traditionally been viewed as strategically important activities with 'natural monopoly' characteristics (Sharkey, 1982; Armstrong et al., 1994). Due to the existence of economies of scale and scope, it was believed that efficiency gains could be obtained by strictly limiting the number of operators, often to one. Because of the importance of the products and services involved, the resulting monopolies in these industries were usually owned by government. However, over the last two decades the inevitable existence of 'natural monopoly' has been rejected for at least some of the activities of the public utilities, including electricity generation. One factor that has contributed to this shift in belief

http://econ.worldbank.org/resource.php?type=18. Eight of our 25 countries also appear in this data base

has been changes in technology. But also budgetary pressures, the preferences of donor agencies such as the World Bank and the perceived poor performance of state-owned firms in terms of costs of production, service quality and service expansion, have led more and more governments to turn to private investors for solutions (Bacon, 1995; World Bank, 1995; Spiller and Martorell, 1996; World Energy Council, 1998).

The earliest reforms in the utilities occurred in telecommunications and much research has focused on this sector (e.g. Noll, 2000; Wallsten, 2001; Li and Xu; 2002; Gutierrez, 2003). More recently, electricity power has been included in the reform process (Joskow, 1998). In summary, reforms in the electric power sector have involved 'unbundling' or vertically separating the industry into generation, transmission, distribution and supply activities, privatisation, introducing competition and establishing more formal and sometimes 'independent' regulatory agencies (Newbery, 1999; Parker, 2003). 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.

Nevertheless, with advances in technology, especially in electricity generation in the form of combined heat and power plants and combined-cycle gas turbine generation, and in the computing systems used to meter and dispatch power, the importance of economies of scale have diminished. Competition has been introduced into the generation and sometimes supply sub-sectors, which are now believed to be subject to increasing marginal costs. It is also expected that entities under dispersed ownership will facilitate competition and that privatising unbundled generators and suppliers will

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so in these cases it was possible to cross-check the dates of institutional reform.

introduce badly needed new financial resources and management expertise (Parker, 2003). As a result, privatisation of electricity power has spread across the developed economies and many developing ones. More than 600 private electricity projects, accounting for investment of US$ 160bn reached financial closure in 70 developing countries during the 1990s (Izaguirre, 2000, p.5).[2] The projects were implemented under schemes ranging from management contracts, to divestitures of state assets, to greenfield facilities under build-operate-own (BOO), build-operate-transfer (BOT) and build-operate-own-transfer (BOOT) schemes,

Latin America, East Asia and the Pacific and the Caribbean have absorbed the lion's share of the investment in projects with private participation, accounting for more than 60% of the total capital invested (Izaguirre, 1998, p.3). In Latin America and the Caribbean privatisation mainly took the effect of transferring existing, state-owned generation to the private sector and private participation has occurred mainly in the context of wider reforms involving vertical separation of the electricity sector. By contrast, in Asia privatisation has been associated more with new, greenfield investments in the form of independent power producers (IPPs) established under various forms of franchises and contracts. Both approaches have been used in Africa and the transition economies of Central and Eastern Europe.

As in other public-utility sectors undergoing reform, developing a new regulatory structure so as to provide more certainty for private investors has been an important part of the reform process in the electric power sector (Kessides, 2004). In order to attract private capital and signal to the incumbents being privatised that they will not

[2] The World Bank (2004, Table 1.1, p.33) estimates the figure for private investment in electricity in

be subject to arbitrary political interference, the development and establishment of a credible and effective regulatory regime has become a recognised feature of the reform process in more and more countries (Cook, 1999; Commander and Killick, 2000). Gutierrez and Berg (2000) identify the importance of effective regulatory governance in achieving performance improvements in Latin American telecommunications. 'Independent' or quasi-independent regulatory bodies, in the forms of offices, agencies and commissions, have been set up, with the expectation that private capital will only be forthcoming to the desired levels if a high degree of regulatory transparency, consistency and accountability exists (Spiller, 1996; Schmitz, 2001; Parker, 2002). Another aspect of independent regulation is the protection of consumers from monopoly abuse. This kind of protection is especially desirable in industries such as electricity supply that may still be dominated by a state-owned incumbent or by a privatised monopoly. Also, a number of studies have underlined the complexity of electricity sector reform (Hunt and Shuttleworth, 1996; Steiner, 2000; ed. Hodge et al., 2004). Unbundling the industry into a number of separate generation, transmission and distribution companies risks reducing economies of scale and scope, and raising transaction costs because legal contracts replace direct management control of the supply chain (Joskow, 2002). Equally, electricity production is associated with various environmental concerns and power producers may be reliant on fuel inputs subject to fluctuating prices. For these reasons, electricity privatisation is never problem free (Newbery, 1999; ed. Hodge et al., 2004).

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both developing and transition economies at US$213.4bn. between 1990 and 2001.

3. Literature Review and the Research Hypotheses

In the early 1990s in Central and Eastern Europe, the unprecedented, radical reconstruction of economies spurred debate as to the proper way of proceeding. Many influential researchers (e.g. Frydman and Rapaczynski, 1991; Lipton and Sachs, 1990; Blanchard et al., 1991) recommended a 'big bang' approach, which favoured mass privatisation. This approach to privatisation emphasised speed, leaving the task of restructuring to the owners of the privatised firms and of establishing the necessary market and legal institutions to subsequent governments. Advocates of mass privatisation seem to have believed that, once private property rights existed, incentive problems within firms would be solved and competition and other institutional reforms would inevitably follow. Quick privatisation was also favoured with the objective of reducing state power and the opportunity for a resurrection of communism (Boycko, et al. 1992).

However, some economists (e.g. Roland, 1994; Summers, 1994) expressed concerns, warning that political constraints and other institutional deficiencies, such as an effective legal system, necessitated a more gradual approach to reform in the transition economies. They argued that privatising without first establishing the effective institutional infrastructures required if private investment is to flourish risked failure (Roland, 1994; Steinfeld, 1998). Neglecting the institutional environment as a pre-condition for successful privatisation would damage the emergence of an effective private financial sector and prevent a gradual 'hardening' of budget constraints (Roland, 1994; Zhang, 2002). The debate on the appropriate

speed of reform has drawn attention to the importance of the appropriate sequencing within reform programmes.

Turning to utilities industries specifically, there has been a broad belief that privatisation is the key to performance improvement (Lalor and Garcia, 1996; Megginson and Netter, 2001) and the introduction of competition and effective regulation has sometimes been neglected (Parker and Kirkpatrick, 2005). In many countries incumbents in the electric power sector, as well as in other infrastructure industries, have been privatised although the institutional framework necessary for the market to function well has been lacking (Spiller, 1993; Cook, 1999; Bitran and Serra, 1998; Lalor and Garcia, 1996; Spiller and Martorell, 1996). Compared to the speed of privatisation in utilities sectors, the process of establishing a new regulatory regime has tended to be slower. Furthermore, the development of effective regulatory structures has, especially in developing countries, been constrained by the capacity of governments to enforce regulatory rules and monitor contracts (ed. Levy and Spiller, 1996). The result is that, with limited numbers of operators and a weak regulatory framework, many privatised companies have retained considerable monopoly powers. At the same time, both the theoretical and empirical literatures have pointed to the importance of competition in raising economic efficiency when privatisation occurs (e.g. Vickers and Yarrow, 1988; Bouin and Michalet, 1991; Martin and Parker, 1997; Kleit and Terrell, 2001; Martin and Vansteenkiste, 2001). As Ambrose et al. (1990) note, simply changing the ownership of a monopoly from public to private will not lead to competitive behaviour. Newbery (1991) suggests that privatising monopolies could be problematic in terms of raising efficiency and has called for the introduction of competition.

In public utility sectors investors in privatised firms naturally have a strong preference for maintaining their economic rents and can be expected to lobby against speedy market liberalisation. In a number of cases, a monopoly status for certain duration has been promised by governments to private investors as a means of encouraging adequate private capital to ensure a successful privatisation (Guasch, 2004). However, in an environment lacking competition, an effective regulatory regime is important to protect consumers. Economic regulation can remove or at least reduce the anti-competitive effects of market dominance. Cook (1999) provides case studies of utility reform in developing economies and finds that regulation rather than privatisation has achieved the largest gains. There is also evidence in the study that, among a variety of reform measures introduced, the most tangible benefits, especially those to consumers, resulted from the establishment of competition.

Galal and Nauriyal (1995) have compared the pre- and post-privatisation performance of the telecommunications industry in seven developing countries. They find that countries that solved three regulatory issues, namely incentives, information and commitment, achieved greater improvement than those that failed to do so. In an empirical study of telecommunications in 30 African and Latin American countries, Wallsten (2001) reported that privatisation, on its own, was not associated with efficiency improvements and needed to be combined with building regulatory capacity. Similarly, studying performance in telecommunications in 22 Latin American countries between 1980 and 1997, Gutierrez (2003) finds that sound regulatory governance has a positive effect on network expansion and efficiency and

competition and divestment by the incumbent operators contributes positively to sector performance.

For the electricity sector, Zelner and Henisz (2000) and Bacon and Besant-Jones (2001) identify the importance of political and institutional variables in determining the pace of reform and new investment (also see Ruffin, 2003); while Bortolotti et al. (1999) conclude that effective regulation is a crucial institutional variable in electricity privatisation. Regulation is important because it helps speed up successful privatisations and affects the proceeds obtained. Using data from electricity industries in 19 OECD countries from 1987 to 1996 to test for the effects of privatisation, competition and regulation, Steiner (2000) provides mixed results but some evidence of higher capacity utilisation with private ownership and industry unbundling. Industrial consumers appear to have benefited most in terms of price reductions following reforms. But Plane (1999) in a study of one privatisation, that of the Côte d'Ivoire Electricity Company, and using parametric and non-parametric tests, reports much less significant performance improvements after privatisation, involving price reductions and improved services. By contrast, studies of electricity reforms in Latin America have tended to reveal efficiency improvements especially in terms of labour productivity, capacity utilisation and energy losses and overall social welfare gains (Delfino and Casarin, 2001; Paredes, 2001; Ennis and Pinto, 2002; Fisher, Gutierrez and Serra, 2003; Torero and Pascó-Font, 2003). Even lower income groups may have benefited, despite reductions in price subsidies, through improved access to electricity supplies. However, there is also evidence of problems including contact cancellations and renegotiations (Guasch, 2004) and capture of welfare gains by government through higher taxes (Estache et al., 2003), once again confirming the complexity of

electricity reform. Zhang et al. (2002) assess the effects of competition, privatisation and regulation on performance in electricity generation in 51 developing countries between 1985 and 2000 and find that it is the introduction of competition rather than ownership change that is most likely to bring about performance gains. Evidence in this study also confirms that the co-existence of privatisation and an independent regulator leads to greater electricity availability, more generation capacity and higher labour productivity. Finally, Estache et al. (2004) rank the efficiency of 84 South American electricity utilities between 1994 and 2001 using both data envelopment analysis and a stochastic cost frontier model,. However, they do not comment specifically on the separate effects of competition, regulation and privatisation.[3]

However, none of these studies considered in any detail, if at all, whether the order and timing of reforms is important. To date the studies that have empirically assessed the significance of sequencing have focused only on the telecommunications sector. Using data for telecommunications from 197 countries for the period 1985-1999, Wallsten (2002) tested whether the order between regulatory reform and privatisation mattered. He found that establishing separate regulatory authorities prior to privatisation was positively correlated with investment and telephone penetration. In a study sponsored by the World Bank, Fink et al. (2002) concluded that mainline penetration in years following the simultaneous introduction of competition and privatisation was significantly higher than when privatisation occurred before competition. They also found evidence of the beneficial effects of having an independent regulator.

[3] Other studies of the electricity sector but less relevant to our study because they relate solely to developed economies are those by Arocena and Waddams-Price (1999), dealing with performance under different regulatory regimes in Spain; Hattori (1999, 2002), who studies the impact of regulatory

In this paper we attempt to assess the impact of the sequencing of privatisation, regulation and competition in the electricity generation sectors of 25 developing countries using a data base especially developed for the purpose of researching market liberalisation, regulation and privatisation policies in such economies. Ideally, the research would also encompass the effects of reform sequencing in the electricity transmission and distribution, but it did not prove possible to obtain the necessary data. This is not be a serious limitation of the study, however, because most of the private capital introduced into the electricity sector in developing countries has gone into generation. Of the privatisation projects in electricity in developing countries in recent years, 73% have involved the construction of power generation plants (Izaguirre, 1988, p.4).

Two sets of hypotheses are tested regarding (1) the order between privatisation and competition, and (2) between privatisation and regulation. As suggested by some of the literature reviewed above, privatising monopolies may provide incumbents with only limited incentives to improve performance because there is still scope for controlling output and because of the management's monopoly of information. Under competition, however, firms must produce efficiently in order to survive. When an incumbent utility is privatised, the existence of competition helps eliminate the remaining scope for managerial slack and the incentive under conditions of monopoly to restrict output below the competitive level. From such arguments, we derive our first hypothesis:

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reforms on the electricity sector in Japan and the US; and Newbery and Pollitt (1997) and Domah and

Hypothesis 1: the introduction of competition prior to the privatisation of electricity generation will yield a greater improvement in output, capacity utilisation and productivity performance.

An incumbent monopolist in the electricity-generating sector faces both the incentive and often the means to prevent competition. While competition is technically possible in electricity generation, new entrants may have to surmount large obstacles to gain a foothold in the market. Increasing the number of electricity generators can prove difficult. Introducing an effective regulatory framework before privatising electricity generation, including encouraging greenfield investments, may therefore help reduce the anti-competitive effects of dominance. The regulator can attempt to achieve a 'level playing field' so that competition develops, for example by ensuring access at 'fair' prices to existing transmission and distribution grids.

Based on such considerations we propose a second hypothesis:

Hypothesis 2: that establishing an independent regulator prior to the privatisation of electricity generation will yield a greater improvement in output, capacity utilisation and productivity performance.

The hypothesised improvements in performance will result from gains in both productive and allocative efficiency. Changes in productive efficiency can be proxied by measures of capital and labour input use. For the measurement of allocative efficiency gains we rely on changes in output or potential output through increased

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Pollitt (2001) who consider electricity sector reform in the UK.

generating capacity. Admittedly this measurement of allocative efficiency is crude, but unfortunately data limitations prevent a closer measurement of the price-cost wedge in electricity generation in developing countries. Also, a lack of data ruled out testing for the effects of competition, regulation and privatisation on service quality.

4. Data and Modelling

The above hypotheses were tested using a panel dataset of 25 developing countries which had privatised electricity generation in the period from 1985 to 2001. The starting date for the study, 1985, was dictated by data availability; although this is not a problem because little reform of the electricity sector in developing countries occurred before this date. The final date, 2001, represented the last year for which data were available at the time the research was conducted. The choice of the sample countries was based on access to data and the countries included are listed in Table 1, along with information on the dates used in the study for privatisation and the introduction of competition and an industry regulator where relevant. The countries are drawn from Latin American and the Caribbean, Africa and Asia.

(Table 1 here)

The primary performance indicators used in the study as dependent variables are net electricity generation per capita, installed generation capacity per capita, electricity generation to average capacity (the capacity utilisation rate) and net generation per employee (labour productivity). The data on electricity generation and generation

capacity came from the database of APERC (Asia Pacific Energy Research Centre) and the data on population from *World Development Indicators* published by the World Bank. The employment data used to compute labour efficiency were compiled from the *Industrial Statistics Yearbook* (various years) and the database of the International Labour Organisation. Ideally, the labour input would reflect both the quantity and quality of the labour force. Unfortunately, international data on labour quality in electricity generation are not available. In common with a number of other studies (e.g, Estache et al., 2004) we use the number of employees as the labour input but also include GDP per capita as an environmental variable to, in part, proxy skill distributions across countries (ibid., p.275).[4] Labour productivity and capacity utilisation rate are used as proxies for productive efficiency, and electricity generation per capita and installed capacity per capita as proxies for allocative efficiency. Information on privatisation, competition, regulation and sequencing were constructed from information in *The Yearbook of Privatisation* (various years), Energy Information Administration (EIA) publications, World Energy Council (WEC) and APERC online publications and the government websites of various countries. The data were cross-checked, where possible, with data published by the World Bank.[5]

There was insufficient, consistent information on the percentage of electricity produced by private companies or the percentage of generation capital owned by private investors to permit a measurement of ownership according to differing levels of state control. Instead, three different dummy variables for privatisation in electricity were used, namely: (1) representing whether there was any privatisation in the electricity sector within a country; (2) whether any privatisation had occurred in

[4] The logic is that where quality differences exist, when GDP per capita is higher there will be fewer

electricity generation; and (3) whether there was any private involvement in electricity provision including the introduction of IPPs (independent power producers). As the regression results were similar for the alternative dummies, we simply report below the results using the dummy for privatisation in generation.[6] The dummy takes the value of 1 beginning the year when some privatisation in generation occurs, even if only partial. Similarly, because of the unavailability of concentration ratio data or similar for the electricity generation sector in the sample of countries, competition was measured by a dummy variable that equalled 1 either when a wholesale market for electricity was introduced or generators were first allowed to compete to conclude supply contracts with distributors or large users. Measuring regulatory effectiveness is always problematic (Domah, Pollitt and Stern, 2002) and particular difficulties arose in measuring regulation for the purposes of this study. Limited published information on the effectiveness of regulation adopted in particular developing countries prevented the construction of a multi-dimensional measurement of regulation that reflected differing degrees of regulatory impact. The measure used was a dummy variable to indicate whether a country claimed to have an electricity regulatory agency not directly under the control of a ministry.[7] For convenience this is described as 'independent regulation', although the degree of independence from government can be quite limited in practice. The regulation dummy takes the value of 1 beginning from the year the regulator was established. The limitations of the reform

units of labour input needed to attain a given production level.

[5] See footnote 1 above.

[6] The alternative results can be obtained from the authors. In the results reported the introduction of IPPs only is not classified as privatisation. This is sensible since the use of IPPs may not signal anything significant about the degree of state control of the electricity sector.

[7] There were two countries in our sample where changes to regulation, competition and privatisation occurred in the same year and three countries where regulation and privatisation were introduced in the same year. Therefore, for most of our sample, reforms to regulation, competition and privatisation occurred sequentially.

variables should be born in mind when interpreting the results, something we return to in the conclusions.

Two sequencing variables were constructed, also taking the form of dummies. One dummy measured the order between competition and privatisation, which equalled 1 from privatisation if the country introduced competition before privatising its generating capacity. The sequencing between regulation and privatisation was measured by another dummy, which similarly took the value of 1 if an independent regulator was in place before privatisation and beginning from the year privatisation occurred. Only two countries in the data set had introduced regulation followed by competition and then privatisation and hence the effects of this sequencing could not be statistically investigated. It is possible that there are lagged effects. To reflect this the sequencing dummies were also time lagged.

Macroeconomic and demographic variables were included in the estimations as environmental controls. They included GDP per capita, the degree of urbanisation (urban population as percentage of the total) and the degree of industrialisation (the percentage of industrial output as a share of GDP). These three control variables were computed based on data from the World Bank's *World Development Indicators*. The amount of income per head and the degree of urbanisation and industrialisation in a country can be expected to be causal factors in determining the amount of electricity generation installed and electricity produced. Richer and more developed and urbanised societies use more electricity power per capita. Political and institutional factors are also now recognised to be potentially important determinants of economic performance differences (North, 1990; Bacon and Besant-Jones, 2001; Jalilian et al.,

2003; Ruffin, 2003) Countries with protected property rights and sound 'law and order' can expect to benefit from higher output levels. A further independent variable was therefore added to reflect a country's 'economic freedom'. The economic freedom variable is intended to serve as a proxy for the wider political and institutional factors that have been associated with economic performance improvements, independent of privatisation, competition and economic regulation, such as freedom of exchange with foreigners, level of government spending and taxation, legal structure and security of property rights and sound money. This variable was based on the 10-point indices published in the *Economic Freedom of the World: 2002 Annual Report* - the higher the score the 'freer' or more liberal the society.

Table 2 lists the variables used in the study and summary statistics and the usual correlation matrix are provided in an Appendix to the paper. The correlation matrix shows a high cross-correlation between the competition before privatisation (SCP) and regulation before privatisation (SRP) sequencing dummies. This means that countries which introduced competition before privatisation were also likely to have introduced an industry regulator. However, as the two variables are not included in the same regressions the cross-correlation is not a problem. In order to control for unobserved country-specific factors, a fixed effects panel model was used.[8] A Hausman test was undertaken which rejected the use of a random effects panel data model. The results for the Hausman test can be obtained from the authors. Log-linear functional specifications were adopted in the regressions to transform a likely non-

[8] The unit root test was conducted and the variables in logged passed the test for stationarity.

linear relationship between the performance indicators and the explanatory variables into a linear one. The regressions took the following forms:

$$\ln y_{it} = \alpha_i + \beta_1(R_{it}) + \beta_2(P_{it}) + \beta_3(SRP_{it}) + \delta(\ln x_{it}) + v_i + \varepsilon_{it} \quad (1)$$

$$\ln y_{it} = a_i + b_1(C_{it}) + b_2(P_{it}) + b_3(SCP_{it}) + \Delta(\ln x_{it}) + w_i + e_{it} \quad (2)$$

where y_{it} is each of the electricity indicators discussed above and listed in Table 2; R_{it}, C_{it}, P_{it} are the regulation, competition and privatisation dummies respectively; SRP_{it} and SCP_{it} represent the two sequencing dummies of regulation before privatisation and competition before privatisation, respectively; x_{it} donates the control variables; v_i and w_i are the unit-specific residuals that differ between units but remain constant for any particular unit; while ε_{it} and e_{it} are the remainder of the disturbance.

(Table 2 here)

Equations (1) and (2) were estimated for each of the four dependent variables - net electricity generation per capita, installed generation capacity per capita, electricity generation to average capacity and net generation per employee. The same regressions were also run substituting lagged sequencing variables. The control variables included varied. In addition to GDP per capita (LGDPP) and economic freedom (LFDOM), the degrees of urbanisation and industrialisation (LUB and LIN) were included in the regressions for electricity generation per capita and generation capacity per capita because of their likely impact on electricity consumption. Also, a large proportion of

industrial customers implies a higher potential for co-generation and a more even demand for electricity. Holding other factors constant, there would, therefore, be a reduction in the need for generation capacity.

It should be noted that the method described so far suffers from a potential problem. That is, that the dummy variables for privatisation, competition and regulation may be endogenously determined. In other words, privatisation, competition and regulation may influence each other, as well as the performance of the electricity sector. For example, the very poorly performing generators may be privatised the most quickly because governments are keen to dispose of them, while better performing generators are sold off more slowly leaving time to introduce prior changes to the regulatory and competitive environment. 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 quality, and year fixed effects control for any general trend in the reform of electricity generation. However, the method does not necessarily remove the problem of endogeneity, in which case, admittedly, any better performance that is associated with regulation or competition reforms before privatisation may not necessarily result from these reforms.

5. Results and Discussion

The Main Estimation Results

Table 3 presents the regression results. The upper half of the table shows the estimation results for the sequence of establishing an independent regulator before privatisation (equation 1 above). The results for the regressions on introducing competition before privatisation are presented in the bottom half of the table (equation 2 above). For all four performance indicators (columns (1), (2) (3) and (4) in the table), the results show that the regulation, privatisation and competition dummies are each statistically insignificant. The results for regulation and privatisation are consistent with the argument that having a separate regulator or privatisation, *on their own*, is not sufficient to improve performance significantly. Indeed, the privatisation and regulation dummies often have a negative sign, suggesting that, on their own, privatisation and the introduction of economic regulation might even reduce performance. However, given the lack of statistical significance and the low coefficient values not much should be read into this result. The coefficient for the competition variable is positive, as expected, but again insignificant. The insignificance of the competition variable is especially surprising because competition is conventionally regarded as a strong agent for efficiency improvement. In summary, these results suggest that each of the three reform elements – competition, regulation and privatisation - has little impact on allocative efficiency and labour and capital productivity in electricity generation in our sample of developing countries.

(Table 3 here.)

However, the coefficients of the regulation-privatisation sequencing dummy (SRP) are positive and significant at the 5% level in the first two columns. This means that establishing an independent regulator before privatising what is likely to be a firm with continuing market dominance is more likely to lead to higher electricity availability and more generation capacity per capita than failing to do so. Although the SRP dummy is positively correlated to the capacity utilisation rate (column (3)), the coefficient only has a significance of 12%, just failing the 10% probability test. The results for the sequencing between competition and regulation (SCP) in equation 2 seem robust for the first three performance indicators, with the coefficients being positive and significant at the 10% level. Introducing competition before privatisation is also associated with improvements in performance compared to when competition is not introduced.

The non–significant results for net electricity generation per employee (column (4)) are unexpected, given that a downsizing of the labour force is widely believed to occur with privatisation or in response to competitive pressures. One explanation for this result may lie in the data used to compute the labour productivity variable. The main source of the employment data is the database of the International Labour Organisation (ILO), combined with employee figures in the electricity sector provided by the *Industrial Statistics Yearbooks*. The data from these two sources are not ideal in terms of either the coverage of countries or the completeness of the data. In addition, the employment figures provided by the ILO include all employees in the electricity sector. Since some sample countries have unbundled their electricity sectors while others have not, using the data to compute labour productivity in electricity generation may give a distorted picture. Also, some of the data from the

Industrial Statistics Yearbooks combine the number of employees in the electricity sector with those in the water industry. In these cases, assumptions were made about the share of the employment in electricity based on the more detailed labour force breakdown in the ILO database. These adjustments, necessitated by the lack of superior data, make the variable net electricity generation per employee potentially less reliable than the other dependent variables used in the regressions. Given this, probably the safest interpretation of the labour productivity results is that they are inconclusive about the effects of sequencing. The discussion in the following section is based mainly on the first three performance indicators.

The control variables conform to expectations, in most cases. The level of income per capita, the degree of urbanisation, the share of industrial output and the measure of economic freedom are all positively correlated with the output and capacity performance measures. For labour and capital productivity (columns 3 and 4) only the economic freedom control variable and GDP per capita are included in the reported regressions because urbanisation and industrialisation are less obviously related to productivity. The results for GDP per head are consistent with expectation that a higher income leads to more electricity consumption and, in turn, higher labour productivity. But the results for the economic freedom variable are either statistically insignificant or display an unexpected negative sign. However, as already discussed, the labour productivity results may not be reliable because of measurement problems.

To test whether the results are sensitive to lagged effects, the two sequencing dummies were time lagged. The SPR dummy then showed a significant and positive effect for capacity utilisation when lagged by one year, suggesting, as perhaps to be

expected, that electricity capacity adjusts after a short lag. Apart from this result, the findings were essentially the same as before.

Discussion

Although they are not the main focus of this study, the generally negative coefficients on the dummies for privatisation and regulation deserve some further comment. Due to data restrictions, the regulation dummy was constructed to indicate whether there is an independent regulator. But almost no government agency is *absolutely* independent of political control and the degree of independence can be expected to vary across countries and over time. Simplifying regulatory policies into a dummy that reflects only the declared existence of an independent regulator by government is broad brush and was necessitated by data availability. There are weaknesses in the privatisation dummy used too, as discussed earlier. Nevertheless, the negative signs on the privatisation and regulation dummies across the estimations are consistent with the argument that privatised monopolies are still able to restrict output and face insufficient incentives to achieve efficiency in the use of capital. In summary, the results, while tentative, are consistent with the view that reform in electricity is a complicated process and that economic success is unlikely to result from a single policy such as privatisation.

The sequencing of reforms is the main focus of this study and the results suggest that subjecting generators to competition ahead of privatisation reduces and may even remove monopoly incentives to restrict output. The research has also found that the establishment ahead of privatisation of an independent regulator reduces monopoly effects on output. Evidence in the study is, therefore, consistent with the hypotheses

that either introducing competition or establishing an independent regulator before privatising electricity generation facilitates the improvement of electricity availability. Supporting evidence is also found for the hypotheses regarding the beneficial effects of reform sequencing on capacity expansion. The significant and positive association between the sequencing dummy of regulation-privatisation suggests that putting a regulator in place, in advance of privatisation, provides private investors with more confidence to invest and expand capacity. In addition, the evidence on reform sequencing and capital productivity confirms a significant positive relationship between capacity utilisation and the sequencing dummies of competition-privatisation and regulation-privatisation, in particular when the latter is time lagged. Firstly, this is consistent with the argument that competition helps eliminate the scope for managerial slack, which may still exist if privatisation occurs without the monopoly power of incumbents being challenged. Removal of managerial slack leads to higher capital productivity. Secondly, it is consistent with the view that having an independent electricity regulator before privatising generators brings about benefits in terms of capacity utilisation.

Finally, regarding the hypothesised improvement in labour productivity, the results are best seen as inconclusive due to data limitations.[9] Nevertheless, in general the results for the sequencing dummies imply that the order and timing of reforms matters. More benefits in terms of improved economic efficiency can be expected if privatisation is undertaken after *either* competition has been introduced *or* an effective regulatory framework has been put in place. The results for regulation before

[9] Fink et al. (2002) in their study of telecommunications contend that alternative sequences of reforms will matter for allocative efficiency but not for productive or what they refer to as internal efficiency. They postulate that privatising before the introduction of competition simply delays productivity gains. However, their argument is not set out in detail and we find that capital productivity in electricity generation does respond to sequencing.

privatisation complement those in the studies by Wallsten (2002) and Fink et al. (2002) of reform sequencing in telecommunications. Wallsten found that countries which established separate regulatory bodies prior to privatisation saw more investment and greater service penetration than those that did not. Fink et al. reported that introducing competition after privatisation led to fewer main lines per population than where competition and privatisation were introduced simultaneously. The results are also complementary to those in Gutierrez (2003) regarding the importance of regulation and competition in determining performance improvement. Table 4 provides a summary of our results in terms of the two hypotheses set out earlier.

(Table 4 here.)

6. Conclusions

Recent research has identified the possible importance of the correct sequencing of reforms if economic performance is to improve as intended (for a very recent endorsement of this view see World Bank, 2004b, p.8). However, to date there has been limited empirical study of the appropriate sequencing of reforms and none, as far as we are aware, relating to the electricity sector. This paper has attempted to fill the gap using data on electricity generation in 25 developing economies over the period from 1985 to 2001. The study has found that having an independent regulator before privatising generation is associated with higher electricity availability and more generating capacity; and introducing competition before undertaking privatisation in electricity generation appears to bring about favourable effects in terms of service

penetration, capacity expansion, capacity utilisation and capital productivity. While it can be hazardous to leap from correlation to causality, the results do seem to confirm that electricity power reform is a complex process and that single reforms, in particular privatisation alone, may well disappoint. It does seem that the sequencing of reforms or more specifically the order of the introduction of privatisation, competition and regulation matters, although much more research is needed before a definite conclusion on the appropriate sequencing can be safely promoted to policy makers.

Admittedly, the study has a number of deficiencies relating to the sample, data availability and endogeneity. As mentioned at the outset of the paper, the sample is a sub-set of a larger data base of reforms in electricity in developing economies and included only those countries for which we had the necessary data on the timing of reforms and where reforms relating to competition or regulation and privatisation occurred. It remains unclear whether the results apply to other countries. Also, future research could usefully concentrate upon developing more reliable competition, regulation and privatisation variables for electricity generation. Our variables are broad brush because of data availability. Also, the data on employment resulted in a failure to provide insightful evidence on labour productivity. Further efforts could be made in the direction of collecting consistent employment data for more countries. Turning to endogeneity, although we attempted to address this issue by including country and year fixed effects, and even though our results are broadly consistent with predictions from the competition, regulation and privatisation literatures, more elaborate models and methods are needed if the potential difficulty is to be eliminated.

Appendix

Summary statistics

Variable	Mean	Std.Dev.	Minimum	Maximum
P	.374117647	.484464532	.000000000	1.00000000
R	.249411765	.433182478	.000000000	1.00000000
C	.141176471	.348613872	.000000000	1.00000000
SRP	.131764706	.338633409	.000000000	1.00000000
SCP	.0776470588	.267930781	.000000000	1.00000000
LUB	4.03815327	.385753394	2.88480071	4.60517019
LIN	3.36869981	.323454464	2.64224265	4.19765297
LGDPP	.755014482	1.01426854	-1.31420049	3.19889584
LFDOM	1.70751725	.243298000	.530628251	2.20055237

Correlation Matrix

	P	R	C	SPR	SPC	LUB	LIN	LGDP	LFDOM
P	1.0								
R	.53204	1.0							
C	.42316	.65149	1.0						
SRP	.52441	.69463	.51009	1.0					
SCP	.38875	.51494	.73362	.74131	1.0				
LUB	.19066	.10641	.24424	.11377	.17908	1.0			
LIN	-.10337	-.23336	-.06835	-.17615	-.03445	.17722	1.0		
LGDPP	.36282	.10519	.11852	.17658	.01632	.58397	.24280	1.0	
LFDOM	.55979	.32118	.31162	.25985	.25138	.03575	-.11672	42361	1.0

Table 1: Country Details

Country	Year of Privatisation in Electricity Generation	Year Independent Regulator Introduced	Year Competition Introduced
Argentina	1992	1991	1992
Barbados	Before 1985	Before 1985	
Bolivia	1995	1994	1994
Brazil	1999	1996	
Chile	1987	1982	Before 1987
Colombia	1996	1994	1995
Dominican Rep.	1998		
Gabon	1997		
Georgia	1999	1999	1999
Guatemala	1998		1997
Hong Kong	Before 1985		
India	1997	1998	
Kazakhstan	1994	1999	
Malaysia	1992		1999
Morocco	1996		
Nicaragua	2001	1998	
Pakistan	1996	1997	
Panama	1998	1998	1998
Peru	1995	1993	1993
Qatar	2000		
Senegal	1999	1999	
South Africa	2001	1995	
Thailand	1995		
Trinidad and Tobago	1998		
Venezuela	1998		

Blanks indicate competition or regulation was not introduced before privatisation.

Table 2: Description of the Variables

Dependent Variables	
	Net electricity generation per capita (KW/person)
	Generation capacity per capita (KW/person)
	Net electricity generation / average installed capacity
	Net electricity generation per employee (million KW/person)

Reform dummy variables	*Description*
R	Regulation dummy
C	Competition dummy
P	The Dummy of privatisation in the generation sector
SCP	The sequencing dummy between privatisation and competition
SRP	The sequencing dummy between privatisation and regulation
Control variables	Description
LGDPP	Log of GDP per capita (1995 constant US$/person)
LUB	Log of urban population as a share of the total (%)
LIN	Log of industrial output as a share of GDP (%)
LFDOM	Log of the degree of economic freedom (%)

Table 3: The Regression Results

	Dependent variable / Independent variable	Electricity generation per capita (1)	Installed generation capacity per capita (2)	Electricity generation/average capacity (3)	Net generation per employee (4)
Equation 1	*R*	-.015	-.005	-.017	.099
		(.778)	(.329)	(.809)	(.809)
	P	-.004	-.006	-.009	.084
		(.191)	(.394)	(.447)	(.938)
	SRP	.062	.044	.040	-.198
		(2.451)**	(2.099)**	(1.555)	(1.418)
	LGDPP	.605	.644	.074	.527
		(12.474)***	(13.724)***	(1.807)*	(2.323)**
	LUB	.925	.436		
		(12.674)***	(3.794)***		
	LIN	.169	.0892		
		(3.072)***	(1.898)*		
	LFDOM	.216	.149	.019	-.555
		(3.258)***	(2.418)***	(.297)	(1.743)*
	Adjusted R^2	.987	.967	.990	.839
	F test	559.60	216.45	768.70	22.02
	D-W test	1.72	1.76	1.75	1.80
	No. of observations	374	374	374	189
Equation 2	*C*	.010	.010	.026	.093
		(.445)	(.536)	(.935)	(.695)
	P	-.006	-.007	-.008	.056
		(.340)	(.464)	(.411)	(.715)
	SCP	.058	.046	.049	-.194
		(1.960)*	(1.846)*	(1.681)*	(1.370)
	LGDPP	.707	.640	.071	.579
		(13.047)***	(13.658)***	(1.739)*	(5.230)***
	LUB	.491	.442		
		(3.632)***	(3.859)***		
	LIN	.123	.085		
		(2.244)***	(1.806)*		
	LFDOM	.165	.150	.018	-.660
		(2.580)**	(2.470)**	(.280)	(2.512)**
	Adjusted R^2	.988	.967	.990	.841
	F test	619.06	213.31	426.31	22.28
	D-W test	1.72	1.77	1.76	1.79
	No. of observations	374	374	374	189

For the key to the independent variables, see Table 1.
t-statistics in parentheses.
*, ** and *** indicate that the coefficient is significant at the 10%, 5% and 1% levels, respectively.

Table 4: Summary of the Research Results

Hypothesis	Results
Hypothesis 1: **Establishing an independent regulator prior to privatising electricity generators will yield a greater improvement in:**	
output	Not Rejected
generating capacity	Not rejected
capacity utilisation	Not rejected (when lagged effect included)
labour productivity	Inconclusive
Hypothesis 2: **Introducing competition prior to privatising electricity generators will yield a greater improvement in:**	
output	Not rejected
generating capacity	Not rejected
capacity utilisation	Not rejected
labour productivity	Inconclusive

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