Reforming Electricity Reforms: Empirical Evidence from Non-OECD Asian Economies

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Abstract

Electricity reforms, implemented through the 'standard' 'model, have their foundations in microeconomics and the rationale that restructuring towards greater competition can lead to higher efficiency, maximise economic welfare, and transfer surplus to consumers. After more than two decades of attempts at reforms, there is a strong case for reviewing empirical evidence on outcomes, specifically in developing countries. This paper investigates the outcomes of the standard model for 17 non-OECD Asian countries, applying instrumental variable regression techniques on an original and previously untested panel dataset from 1990-2013. Our results show a tension between wider economic impacts and welfare impacts for consumers. They confirm that institutional factors have influenced outcomes, and that the uniform application of the 'standard' model without reference to country-specific heterogeneity has not resulted in the outcomes originally intended. Our results call for a renewed thinking of electricity reforms.

Keywords: market liberalisation; electricity restructuring; development; welfare

JEL Classification: H54, O13, L94, P11, Q48

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1. Introduction

Electricity sector reforms worldwide are undergoing introspection following more than two decades of liberalisation. While this is partly related to the emergence of goals on decarbonisation, it is also related to the effectiveness of the original 'textbook' or 'standard' model of reforms in improving economic and technical efficiency, and social welfare. The 'textbook' model, which was pioneered in the 1980s/90s by major OECD economies - the UK, Norway, Chile and the US - was targeted at improving the efficiency of operation of utilities, implementation of cost-reflective pricing based on competitive wholesale and retail markets in generation and distribution, and effective operation of transmission networks by an independent system operator (Pollitt, 2004). The textbook model typically comprised a set of policy measures, including (Sen, 2014; Gratwick and Eberhard, 2008; Joskow, 2008; Victor and Heller, 2007):

- the opening up of the sector to private generation companies or Independent Power Producers (IPPs);
- the unbundling and corporatisation of vertically integrated state-owned utilities into competitive (generation and supply) and regulated natural monopoly (distribution, transmission and system operation) functions and the commercialisation of these;
- the enactment of electricity legislation;
- the establishment of independent regulation; and,
- the divestiture or privatisation of the sector.[4]

In the OECD, reforms were implemented against the context of excess capacity and stable institutions, to improve sector performance and potentially lower consumer prices. In contrast, in non-OECD developing countries, reforms were predicated on multilateral lending, and implemented against the backdrop of electricity shortages, weak institutions, and complex political factors.[5] Consequently, the viability of this model for the institutional contexts of developing countries is debatable (Sen, 2014; Nepal and Jamasb, 2012a, 2012b; Gratwick and Eberhard, 2008; Williams and Ghanadan, 2006; World Bank, 1993). While distributional issues[6] are higher priority in developing countries relative to OECD countries, the underlying rationale for reforms postulates that restructuring towards greater competition can improve technical and economic efficiency. Governments assumed that the successful implementation of market-oriented reforms would also automatically pass the efficiency gains to consumers (Jamasb et al., 2015). The institutional heterogeneity amongst non-OECD countries, however, complicates the effectiveness of reforms (Nepal and Jamasb, 2012a). Whilst in the OECD, the scrutiny over reforms relates to their suitability in delivering low-carbon systems, in non-OECD Asia, it pertains to whether the textbook model has delivered the expected efficiency and welfare impacts (the maximisation of not just total but also consumer surplus). These issues merit a comprehensive empirical analysis of electricity reforms in developing Asia, focusing on the gap between anticipated and actual outcomes.

This paper addresses the following research question: to what extent have electricity reforms in non-OECD Asia led to anticipated outcomes from the 'textbook' model? This paper fills a gap in existing literature: first, to our knowledge, it is the first paper to empirically assess the impact of electricity reforms on non-OECD Asian countries as a whole. Second, it applies econometric techniques to a new panel dataset of 17 non-OECD Asian economies, from 1990-2013, allowing for cross-country comparisons whilst controlling for differing institutional and political contexts. Third, it draws the link between electricity reform and sector (technical) performance, economic impacts, and welfare indicators, assuming a cumulative impact of reform.

[4] With exceptions – for instance, Norway (Bye and Hope, 2005).
[5] Such as ccorruption and patronage. See Victor and Heller (2007).
[6] For instance, the lack of access to electricity.

The next section summarises the experience of reform in non-OECD developing Asia. Section 3 discusses the gap in empirical literature and main hypotheses. Section 4 describes the methodology, data, and econometric estimation, followed by a discussion based on the main results in Section 5. Section 6 concludes.

2. Electricity Reform in Non-OECD Asia

The 17 non-OECD countries in our study[7] account for 34% of world primary energy demand, 60% of population and around two-thirds of the world's poor (IEA, 2014), implying that reforms have implications for global energy use and socioeconomic welfare. Although the pace has differed, reforms have been characterised by similar underlying problems – inefficiency, below-cost pricing, high technical and commercial losses, and weak institutions. Table 1 depicts the progress of reforms set against the 'standard' reform model used to assess its milestones (Gratwick and Eberhard, 2008; Joskow, 2008).

The entry of Independent Power Producers (IPPs) into generation is the most widely adopted measure. IPPs were introduced through a wave of popularity in the early 1990s, as the quickest way to inject competition without restructuring. They transferred investment risks to utilities and in some cases ultimately to consumers (through higher tariffs) through the 'take or pay' clauses prevalent in many contracts. While some countries (e.g., Malaysia and Singapore) coped by evolving their sectors to adapt to this risk, many struggled to harness IPPs to fit with their fiscal and institutional contexts. In India and Pakistan, the inability of utilities to recoup higher IPP tariffs from consumers who paid prices below cost led to a spate of renegotiations and cancellations in the 1990s (Mukherjee, 2014; Kessides, 2013). However, following third party access in the 2000s, IPPs in India have provided a functional alternative to inadequate public sector investments in capacity additions, through the auctioning of low-cost domestic coal supply linkages to IPPs.[8] Political factors have markedly impeded IPPs' success. For instance, the Philippines in the 1990s successfully contracted IPPs for 40% of generation capacity, as did Indonesia – however, following the Asian financial crisis a spate of renegotiations uncovered allegations of patronage in the awarding of IPP contracts in both countries (Henisz and Zelner, 2002; Wu and Sulistiyanto, 2013). Similarly, political upheaval stalled IPPs in Thailand (Wu, 2005a).

Among smaller countries, Laos, Bhutan and Nepal have significant hydropower potential, some of which has been developed through IPPs. However, concerns over property rights and sovereignty over hydro resources have prevented their progress.[9] In China, the lack of grid integration meant that despite the early introduction of IPPs, capacity surpluses could not be spread to deficit regions, making IPP investments susceptible to regional supply and demand fluctuations (Wu, 2005b). The reorientation of multilateral financing towards clean energy has stalled IPPs in newly hydrocarbon-rich countries such as Bangladesh and Myanmar. Singapore is one of the few non-OECD Asian countries to have achieved liberalised markets incorporating IPPs. However, an oversupply combined with high gas take-or-pay arrangements have driven market prices down to short-run marginal cost, deterring new investments (Somani and Lim, 2014). Improvements in market design, such as setting up a futures market, were undertaken to resolve this.

[7] The 17 countries that we use in this analysis are: Bangladesh, Bhutan, Brunei Darussalam, China, India, Indonesia, Laos, Malaysia, Maldives, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand and Vietnam. Our selection was constrained by the availability of data.

[8] Cheaper coal ensured lower tariffs but with enormous adverse environmental consequences.

[9] Negotiations between Nepal and India over Indian investment in Nepal's hydropower infrastructure faced public protests citing concerns over the acquiescing of Nepal's national sovereignty.

Table 1: Electricity Reforms in Non-OECD Asia, 2013

	Independent Power Producers	Regulator	Unbundling	Corporatisation	Open/Third Party Access[10]	Distribution Privatisation
Bangladesh	x	x	x	x		
Bhutan	x	x	x	x		
Brunei		x				x
China	x	x	x	x		
India	x	x	x	x	x	x
Indonesia	x		x	x	x	
Laos	x					
Malaysia	x	x	x	x		
Maldives	x	x		x		
Myanmar	x	x				
Nepal	x	x	x	x		
Pakistan	x	x	x	x		
Philippines	x	x	x	x	x	x
Singapore	x	x	x	x	x	x
Sri Lanka	x	x				
Thailand	x	x	x	x	x	
Vietnam	x	x	x	x		

Source: Authors

The establishment of electricity regulators occurred around the early to mid-2000s. Fifteen out of seventeen counties (Indonesia and Laos being the exceptions) have established some type of regulator – however, in most cases these are not independent from government. In countries where electricity reform is lagging, the main issue faced by regulators relates to reforming tariffs to reflect costs (e.g., India and Pakistan). Where markets have largely developed, issues include the mitigation of market power, which in many cases is exercised by state owned companies. For instance, in Thailand the regulator is tasked with 'promoting competition' while contradictorily 'supporting' the position of previously dominant state-owned enterprises (Wisuttisak, 2012). China has aimed at consolidating electricity regulation with other energy-related sectors to 'protect other objectives such as health and safety, and environmental and consumer protection' (Ngan, 2010). In smaller import-dependent countries such as Maldives, the regulator plays a critical role in the country's trade balance.[11] In Singapore the regulator has successfully dealt with market power through regulating 'vesting contracts' – bilateral agreements between generation companies and market support services licensees[12] which require generation companies to sell a set amount of electricity at a specified price. This limits the ability of larger generation companies to exercise market power via capacity withholding during scarcity periods to push up wholesale spot prices (Chang and Li, 2013). In the Philippines, the regulator has struggled with the highly politicised issue of tariffs, and with market power exercised by government utilities (Santiago and Roxas, 2010).

Unbundling implies the structural and functional separation of electricity production and supply into its competitive (generation and retail supply) and non-competitive (distribution and transmission) components. While unbundling implies 'accounting separation', corporatisation implies the commercialisation of unbundled entities or their incorporation as commercial businesses under

[10] Open access has been implemented to varying degrees; in the majority it has been confined to large consumers.
[11] Maldives aims to achieve 'carbon neutrality' in energy by 2020.
[12] Which provide metering and billing services to consumers (Chang and Li, 2013).

Company Law –mandating economically-motivated (as opposed to politically-motivated) operational decisions. Although the majority of countries have implemented unbundling and corporatisation, public sector provision largely dominates and in many cases the finances of distribution companies have not improved. Although the logic of market-driven reforms would imply that corporatisation follows unbundling, actual experiences have varied. Brunei, Laos, Myanmar and Sri Lanka have retained vertically integrated public sector monopolies. They have relatively small power systems and indeed Nepal and Jamasb (2012b) argue that in smaller systems, the creation of an independent regulatory authority may be more important than unbundling, particularly for politically unstable countries and especially where hydropower is predominant. Contradictory to the 'logical' reform sequence, several countries corporatized prior to unbundling, which often took place several years after corporatization (China[13], Philippines, Vietnam).

Open/third party access to the grid is a fundamental enabling factor of reform, as it facilitates competition. First, consumers of public sector utilities are permitted to opt out of receiving supply from those utilities; and second, consumers as well as private sector generation and distribution utilities are able to access network infrastructure that has typically been dominated by public sector utilities. Open access has been implemented in just five countries, with some obstacles. In India, for instance, the main impediment has been the imposition of 'surcharges' by public utility companies on large industrial consumers to compensate for the loss in revenue.[14] In Indonesia, the state company PLN continues to be the sole owner of transmission and distribution assets as it is given priority rights under the law to conduct its business. In Thailand, despite open access public sector companies operate geographically segregated oligopolies and have majority shares in private generation companies, with limited effectiveness in engendering competition (Wisuttisak, 2012). In Singapore however, retail market liberalisation was carried out in two phases beginning in 2003, and roughly 80 per cent of (contestable) demand is exposed to retail choice.

Four countries: Brunei, India, Philippines and Singapore have implemented distribution privatisation. Singapore is arguably the most advanced, with seven electricity retailers and the Market Support Services Licensee (MSSL) competing for (contestable) retail consumers. Privatisation in the Philippines' electricity distribution sector has on the other hand resembled the switch from a public to a private monopoly, as the National Power Corporation controls the majority of electricity production through direct ownership shares in generation companies or long term contracts with IPPs (Blank et al., 2012). In Brunei, the Berakas Power Management Company is a private limited company that owns and operates distribution substations and networks. In India, distribution privatisation has been implemented in two states: Orissa in 1996 as part of World Bank reforms was deemed unsuccessful as it was carried out without any restructuring or financial reform; Delhi in 2002 was deemed relatively successful as the bids were awarded on the basis of the largest promised reductions in average commercial and technical losses, with the gains shared with consumers.[15]

3. Review of Literature

The underlying rationale for reforms draws from microeconomics and industrial organisation, postulating improved efficiency, maximisation of economic surpluses and enhancements in consumer welfare (Armstrong and Sappington, 2006). Although standard microeconomic theory shows that welfare (consumer *plus* producer surplus) is maximised under perfect competition whereas monopoly

[13] See Dupuy et al. (2015) for a discussion of 'Document 9' detailing China's power sector reforms.
[14] Industrial consumers cross subsidise agricultural consumers; hence in the absence of tariff reform, open access has serious financial consequences for public utilities.
[15] Delhi is a special case as it is a predominantly urban state and has no agricultural consumers.

leads to deadweight loss, in the pre- reform era, the electricity industry was seen as best organised around increasing returns to scale and cost efficiencies realised by a monopoly market structure (Steiner, 2000).[16] Governments instituted public ownership to ensure that state-owned companies would not maximise profits, thus enhancing consumer welfare (Steiner, 2000). Although this aided distributional goals[17] it risked regulatory capture by interest groups, causing regulators to set prices as close to variable costs of production as possible, and impeding investment. Technological advances reduced the minimum efficient scale of operation, enabling the functional decomposition of the industry (Steiner, 2000). Against this changing context, it was argued that replacing regulation with competition could increase efficiency, and liberalisation was seen as complementing competition (Newbery, 1996; Steiner, 2000).[18]

The removal of entry barriers is crucial to welfare-enhancing competition (Armstrong and Sappington, 2006). Although privatisation was not deemed necessary to engendering competition (Newbery, 2006), relative to monopoly, private companies' focus on lowering costs can generate a higher surplus and potentially be welfare-enhancing. However, under vertically integrated public ownership in countries with weak institutions, prices are often set below costs at the outset, to subsidise poorer consumers through the pricing system. Kahn (1979) argued that liberalisation can be welfare-enhancing only when average costs are above marginal costs, as competition can drive down system average costs and potentially final prices; but when average costs lie below marginal costs at the outset, rising prices are more likely. While competition undermines cross-subsidies, liberalisation and privatisation could still be welfare-enhancing when combined with lump sum payments to consumers who are made worse off (Armstrong and Sappington, 2006).

The literature on reform outcomes in developing countries is limited relative to developed-country studies, as the former are subject to country-specific factors (Jamasb et al., 2015). In general, empirical studies find positive reform outcomes on sector performance and efficiency. Cubbin and Stern (2004; 2006) apply OLS regression to panel data for 28 developing countries over 21 years, concluding that regulation improves per capita electricity generation and installed capacity. Nagayama (2010) similarly applies fixed effects models to 86 developed and developing countries, concluding that reforms (IPPs, unbundling, regulation and wholesale markets) led to lower transmission and distribution losses. Erdogdu (2014) using panel data on 55 developed and developing countries over 35 years finds, with fixed and random effects models, that reforms have led to higher levels of electricity self-sufficiency. A sub-literature focusing on productivity and efficiency analysis of utilities, argues that the distribution of efficiency gains relies on the strength of the regulatory framework (Jamasb et al., 2005).

The literature analysing the distribution of economic surpluses arising from efficiency gains shows mixed evidence. A prominent area of focus is consumer prices; Nagayama (2009) uses ordered response, fixed and random effects models to analyse panel data for 78 developed and developing countries from 1985-2003 and finds that higher electricity prices tend to drive liberalisation, but liberalisation does not necessarily reduce prices. Sen and Jamasb (2012) utilise bias corrected fixed effects models on panel data for 19 Indian states, to find that prices increased in the early stages of reform. Erdogdu (2013) uses fixed and random effects models on 63 developed and developing countries over 27 years with no conclusive impact on price-cost margins or cross-subsidy levels. In contrast, ESMAP (2011) applies panel data techniques on 20 countries, concluding that vertical unbundling reduced electricity prices by 10%. Another area of welfare gains pertains to access; this

[16] For instance, as the number of consumers supplied by a utility increased, reserve margin requirements decreased because the grouping of heterogeneous consumers pooled the risk faced by the supplier, thereby reducing, operating and capital costs (Steiner, 2000). Further, duplicative fixed costs of production could be avoided (Armstrong and Sappington, 2006).

[17] A profit-maximising monopolist may in theory prefer to serve low-cost areas, which excludes higher-cost, unconnected consumers in rural areas.

[18] However, liberalisation redistributes rents and raises new regulatory problems (Newbery, 1996).

points to a critical role for regulation. ESMAP (2011) uses panel data for 20 developing countries to show that independent regulation increased electricity access substantially. Balza et al. (2013) find similar results using GLS estimations on 18 Latin American countries.

However, a gap in the literature becomes evident as one moves from reform outcomes in terms of performance and efficiency gains to their impact and links with wider welfare indicators. One approach has been to assume a positive cumulative impact from reform on macroeconomic indicators. Sen and Jamasb (2012) use bias corrected least squares regressions on a panel dataset of 19 Indian states observed over 16 years to show that reforms had a net positive impact on state-level GDP. Vu and Gurtoo (2014) econometrically extrapolate links between utility sector reform, socioeconomic development and poverty reduction for five South Asian economies from 1990-2008. Jamasb et al. (2015) show that most welfare studies mainly consist of qualitative case studies combined with social cost-benefit analysis at the utility level, or micro level single-country cross-sectional household survey data using Maximum Likelihood probit models (Khandker et al., 2012a; 2012b). The role of institutional heterogeneity on welfare outcomes has also been poorly explored, primarily due to complicated model specification issues (Kessides, 2012). Studies which utilise bias-corrected least squares estimations to deal with institutional heterogeneity include: Nepal and Jamasb (2012a) relate the effectiveness of electricity reform to wider institutional indices of governance, finance, and infrastructure for a panel comprising 27 transition economies; Balza et al. (2013) utilise a 'polity' index capturing relative autocracy or democracy for 18 Latin American countries; and, Erdogdu (2013) investigates the impact of political economy variables on electricity liberalisation for 55 countries. Although these find significant links between reforms and institutions, the models assume exogeneity in the regressors which it can be argued is not robust.

3.1 Hypotheses

The empirical method consists of three hypotheses. Our conceptual approach is that each hypothesis builds on the preceding one, and in this we draw from existing literature and evidence. We draw from the literature to assemble a set of indicators which reflect the impacts of electricity reform. Second, we group these variables into categories reflecting the type of impacts they represent – technical (through efficiency improvements), economic (through the maximisation of total surplus) and welfare (through the expected transfer of surplus to consumers). And third, we regress reform measures (with relevant controls) on these representative impact variables, whilst controlling for institutional and political differences, and differing resource endowments, using panel data on 17 non-OECD Asian economies for 1990-2013. The choice of variables is informed by data availability.[19]

The most immediate impact of electricity sector reform should be on sector performance *per se;* broadly speaking - technical improvements. For instance, high transmission and distribution losses can be a result of inadequate investments in network maintenance, tied to capital constraints resulting from below-cost pricing. Similarly, operational improvements can also be tied to the success of electricity reforms in the rationalisation of subsidies – which are widely prevalent in non-OECD Asia. Our first hypothesis therefore focuses on the technical impact of electricity reforms:

H1. Electricity sector reforms in non-OECD Asian countries have reduced technical losses.

We use per capita transmission and distribution losses as the dependent variable – also the most widely used variable in the literature.[20] Our main explanatory variable is an additive electricity reform index, drawing from Balza et al. (2013), Nepal and Jamasb (2012a), Sen and Jamasb (2012),

[19] See Table 3.

[20] A potential limitation of using a per capita measure of T&D losses is that electrification is not complete in all the countries in our dataset. However, most studies utilise per capita measures, particularly for developing countries, due to issues related to data availability and standardisation. We therefore use per capita measures.

Nagayama (2007), Cubbin and Stern (2005), and Hattori and Tsutsui (2004). The index comprises six measures: (a) IPPs in generation, (b) an electricity regulator as a separate, distinctive body,[21] (c) unbundling of the state utility, (d) corporatisation of the utility, (e) open / third party access to network infrastructure, and (f) distribution privatisation. We construct our index based on the features of electricity reform in non-OECD Asia. For instance – while unbundling and corporatisation are often considered together in the textbook model, in reality, corporatisation (or the incorporation of a utility under the 'Companies Act') implies a greater likelihood of commercialised operations. Similarly, most of the countries do not have truly independent regulators. Dummies (0/1) are assigned to each measure and we aim to regress both the individual scores and additive index on the dependent variable in our initial runs. Following Zhang and Kirkpatrick (2005) and Cubbin and Stern (2006; 2004), we include three interaction terms among our regressors: *[regulation*distribution privatisation]*, on the assumption that privatisation cannot work without effective regulation; *[IPPs*open or third party access]*, on the assumption that open access to networks enables consumers to harness the full potential of electricity generated by IPPs[22]; and *[unbundling*corporatisation]*. The reasoning is that unbundling is ineffective without corporatisation as unbundling by itself simply transforms the firm from a large public monopoly to a small public monopoly. We control for differences in institutional capacities by using an internationally recognised transparency index – the Corruption Perceptions Index (CPI) which is a composite index, a combination of surveys and assessments of corruption, collected by a variety of reputable institutions, and is the most widely used indicator of transparency worldwide.[23] Stronger institutions and governance should enable transparency of operations, less rent-seeking and more effective outcomes. We include per capita power consumption as a control– as higher power consumption in absolute terms would lead to higher transmission and distribution losses**.**

Our second hypothesis broadens the scope of electricity reform impacts beyond sector performance, drawing from Vu and Gurtoo (2014), Erdogdu (2013), Nepal and Jamasb (2012a) and Sen and Jamasb (2012) to postulate the economic impact of electricity reform:

H2. Electricity reforms in developing, non-OECD Asia have led to positive impacts on economic growth.

We use per capita GDP as our main dependent variable – consistent with literature; independent variables include the individual and total reform scores, along with the three interaction terms described above. We control for institutional differences using the transparency index, and differences in initial resource endowments using per capita total installed capacity.[24] A secondary indicator of economic impacts is the openness of economies to international trade (or in this case, inter-regional trade that is mostly bilateral).[25] We therefore estimate a second equation using per capita electricity trade (defined as electricity exports + electricity imports as a percentage of total electricity generation)[26] as our dependent variable. We use the same set of regressors as for per capita GDP. As several countries in developing non-OECD Asia are generously endowed with hydroelectric reserves, we subtract hydroelectric capacity from total installed capacity and include it separately as one of the regressors to account for its effect. Our final hypothesis extends the empirical analysis to consumer

[21] Whether independent or not.
[22] As opposed to a situation in which IPPs can only sell electricity directly to state utilities. As seen in the literature, the chronic financial crises faced by many state owned utilities limits the effectiveness of IPPs in generation.
[23] The Transparency Index is a country-specific composite index measuring perceptions of corruption in the public sector. It is the only internationally recognised, cross-country dataset measuring governance and institutional capacity. The detailed methodology and dataset are available to freely download from http://www.transparency.org/cpi2014/in_detail.
[24] While an alternative would be to use some indicator of primary energy reserves, installed capacity is closer to the realities of the situation in these economies that we wish to simulate, as it represents the existing infrastructural capacity to deliver these resource endowments to the population. Further, this captures the cumulative effects of resource endowments in a dynamic rather than static form.
[25] Frankel and Romer (1999) is one of the forerunner studies examining trade and economic growth by geographic region.
[26] This is consistent with the World Bank World Development Indicators' definition of trade.

welfare– which has been absent or patchy in the current empirical discourse. The welfare impact of electricity sector reform can be captured in the following hypothesis:

H3. Electricity sector reforms in developing, non-OECD Asian economies have led to positive impacts on consumer welfare.

We use two separate estimations, and hence two dependent variables. The first is the Gini coefficient, which captures the welfare aspect through its representation of income distribution. And second is the Human Development Index (HDI), which covers social wellbeing in a wider sense through its representation of standard of living, educational attainment and life expectancy in a society.[27] Explanatory variables include the individual and total reform scores and interaction terms. As a number of other country-specific factors could influence the dependent and independent variables in each estimation, we rely on the choice of control variables and choice of estimator to account for these differences. As controls, we include the transparency index and per capita electric power consumption.[28] The characteristics of the variables included in our hypotheses imply that the random shocks that affect the social, economic and technical impacts in these economies are also likely to affect the formulation and implementation of reforms. We therefore use an index of political reform and civil liberties in our estimations to instrument for reform, as the overall level of political freedom can affect the social, economic and technical variables, as well as the ability to formulate and implement reforms.[29] In this way, we are able to also estimate reform impacts under different country-specific political frameworks.

In addition to the three hypotheses above, we are interested in the effects of reform on investment in generation –measured through the per capita stock of installed generating capacity, and also, on per capita hydroelectric installed capacity. We consider these to be an important corollary to the three hypotheses for two reasons. First, most countries have suffered from chronic electricity deficits, and reforms were carried out in the absence of excess capacity. The impact of reforms on the stock of installed capacity is therefore relevant. And second, several countries in our dataset have considerable amounts of hydroelectric resources. We therefore include results from two additional estimations to explore these effects.

4 Empirical Method and Data

4.1 Methodology

Our dataset constitutes an unbalanced panel with 17 cross-sections from 1990-2013. Each cross section represents a non-OECD Asian economy, with a range of country-specific unobserved factors influencing the behaviour of each. We utilise panel data econometric techniques as they are best placed to deal with heterogeneity in the micro-units[30]. We would typically use fixed effects (LSDV) estimators as they are best placed to deal with unobserved heterogeneity contained in the cross-sections, as the individual effects could be correlated with the explanatory or independent variables. However, our dataset has a finite and relatively small time dimension, '*T*' and a LSDV model biases estimates when *T* is small (Judson and Owen, 1999). Kiviet (1995) devised a bias-

[27] Measured through per capita income, mean years of schooling and expected years of schooling, and life expectancy at birth.

[28] A more accurate control variable would be electrification rates – however, the scarcity of time-variant data on this variable prevented us from using this variable in our estimation.

[29] The data was obtained from the 'Freedom in the World Report' published by Freedom House and freely available at https://freedomhouse.org/reports

[30] Kennedy (2008) discusses panel data techniques of fixed versus random effects estimators in applied econometric research.

corrected LSDV estimator (LSDVC), later refined by Bun and Kiviet (2003), which is generally seen to have the lowest RMSE[31] for panels of all sizes; its applicability was, however, limited to balanced panels. A version of the bias-corrected LSDV estimator (LSDVC) for unbalanced panels was developed by Bruno (2005), which operates under two assumptions; first, it has a strictly exogenous selection rule, and second, it classifies the error term ε_{it} as an 'unobserved white noise disturbance' (Bruno, 2005). However, the bias corrected LSDV estimator operates on an exogenous selection rule, and we cannot rule out endogeneity amongst our regressors. A number of consistent Instrumental Variable (IV)[32] and Generalised Method of Moments (GMM)[33] estimators have therefore been proposed in econometric literature as alternatives to the bias corrected LSDV estimator. We opt for an instrumented variable regression using the STATA routine *ivregress*.[34] This fits a linear regression of *depvar* on $varlist_1$ and $varlist_2$, using $varlist_{iv}$ (along with $varlist_1$) as instruments for $varlist_2$.[35] It supports estimation using two-stage least squares (2SLS) and GMM estimators.

The model estimated under this routine is as follows:

$$y_i = Y_i\beta_1 + x_{1i}\beta_2 + u_i \qquad \textit{(Structural equation)} \quad (1)$$

$$Y_i = x_{1i}\Pi_1 + x_{2i}\Pi_2 + v_i \qquad \textit{(First-stage equation)} \quad (2)$$

Here, y_i is the dependent variable for the *i*th observation, Y_i represents the endogenous regressors, x_{1i} and x_{2i} represent the instruments and u_i and v_i are zero-mean error terms, and the correlations between u_i and the elements of v_i are presumably non-zero. Our choice of instruments is guided by cross-correlations amongst the regressors. Pre-estimation procedures reveal problems with collinearity and endogeneity, in particular with the variables representing the total reforms index and distribution privatisation. As we are primarily interested in assessing the impacts of individual reform measures, we drop the total reforms index in our estimations. We then instrument for distribution privatisation using an index of political reform[36] since we treat distribution privatisation as endogenous. This specification is guided by two factors: first, the literature shows strong evidence of political and populist opposition to electricity privatisation in developing countries, due to its inability to deliver for the poor, and also its association with governance failures, political suppression, and regional and ethnic conflicts (Roland, 2008). Such opposition has involved dynamic interactions with existing political parties and structures, including the use of existing electoral and judicial mechanisms (Hall, et al., 2005). Second, the correlation (higher relative to the other variables in our dataset) between distribution privatization and political freedom allows us to assume that both the index of political reform and civil liberties are correlated with distribution privatization (i.e. the endogenous variable) but uncorrelated with the error term. In our estimation method, apart from any additional exogenous variables that are specified, other exogenous variables that appear in the regression equation are automatically included as instruments. The results are robust to heteroscedasticity, and we run both GMM and 2SLS estimations to test for consistency.

We report the R-squared (goodness of fit) statistic along with our results, although the estimator suppresses it in the reporting of results in some cases, or reports a low statistic; but it should be noted that R-squared has no statistical meaning for instrumental variables regression.[37] Instead, we carry out two post-estimation tests to validate the robustness of our results. The first is a test of endogeneity,

[31] Root Mean Square Error.
[32] Baum (2006); Wooldridge (2010; 2013).
[33] Hall (2005).
[34] The syntax for *ivregress* assumes that you want to fit one equation form a system of equations or an equation for which you do not want to specify the functional form for the remaining equations of the system. An advantage of *ivregress* is that you can fit one equation of a multiple-equation system without specifying the functional form of the remaining equations.
[35] $varlist_1$ and $varlist_{iv}$ are the exogenous variables, and $varlist_2$ the endogenous variables.
[36] The Freedom House index, as discussed in earlier sections.
[37] See Stata manual http://www.stata.com/support/faqs/statistics/two-stage-least-squares/

which tests whether endogenous regressors in the model are in fact exogenous. The second is a test of over-identifying restrictions, which checks the validity of the instruments. For the GMM estimations, the test for endogeneity is reported through the 'C' statistic (Hayashi, 2000), and the test of over-identifying restrictions is reported through the GMM Hansen J statistic (Sargan, 1958; Hansen, 1982). For the 2SLS estimations, endogeneity is reported through the Wooldridge score test (Wooldridge, 1995) and regressions-based test (Durbin, 1954; Wu, 1973; Hausman, 1978), while the test of over-identifying restrictions is based on the Sargan (chi) (Sargan, 1975) and Basmann (chi) (Basmann, 1957) test statistics.

4.2 Data

Data was gathered to assess the progress of electricity sector reform against the 'typical' set of measures in Table 1, along with dependent and explanatory variables (Tables 2 and 3 contain full descriptions). Our data was compiled from large, well-publicised datasets, which reduces problems with standardisation. These included the World Bank's World Development Indicators, International Monetary Fund database, and Freedom House Index.

The Transparency International Index from which we obtain our institutional indicator, is originally compiled from 12 sources: African Development Bank Governance Ratings, Bertelsmann Foundation Sustainable Governance Indicators, Bertelsmann Foundation Transformation Index, Economist Intelligence Unit Country Risk Ratings, Freedom House Nations in Transit, Global Insight Country Risk Ratings, IMD Competitiveness Yearbook, Political and Economic Risk Consultancy Asian Intelligence, Political Risk Services International Country Risk Guide, World Bank Country Policy and Institutional Assessment, World Economic Forum Expert Opinion Survey, and World Justice Project Rule of Law Index.

Our electricity reform measures were constructed through carrying out a comprehensive survey of country-specific literature to ascertain the status and progress of electricity reforms in non-OECD Asia. The variables were scaled to represent per capita data and were further standardised by carrying out log transformations (see Appendices for summary statistics).[38]

Table 2: Technical, Economic and Welfare Impacts of Electricity Sector Reform in 17 non-OECD Asian Economies, 1990-2013

	Dependent Variable	Explanatory Variables	Control Variables
Technical Impact	1. Per capita transmission & distribution losses	Individual reform scores; Reform Index (instrumented) interaction terms	Per capita electric power consumption; transparency index
Economic Impact	1. Per capita GDP	Individual reform scores; Reform Index (instrumented); interaction terms	Per capita total installed capacity, transparency index

[38] We log transform all variables apart from the reform index and individual reform measures. Log transformations are typically carried out to linearize relationships in the model, to remove heteroscedasticity, and to obtain residuals that are approximately symmetrically distributed. Marginal changes in the explanatory variables are interpreted in terms of multiplicative (percentage) changes in the dependent variable. When both dependent and independent variables are logged (log-log relationship), the regression coefficients are interpreted as elasticities. Further, a log-level relationship (*logY* and *X*) is interpreted as follows: $\% \Delta y = 100.(e^{\beta_1} - 1)$. However, in our discussion of results, we focus primarily on the direction of causality as we aim to investigate the high-level impact of reforms as opposed to the precise magnitude of the effects.

	2. Per capita electricity trade	Individual reform scores; Reform Index (instrumented); interaction terms	Per capita total installed capacity (minus hydro installed capacity); per capita hydro installed capacity, transparency index
Welfare Impact	1. Gini coefficient	Individual reform scores; Reform Index (instrumented); interaction terms	Per capita electric power consumption, transparency index
	2. Human Development Index	Individual reform scores; Reform Index (instrumented); interaction terms	Per capita electric power consumption; transparency index

Source: Authors

Table 3: Variable names and units of measurement

Variable Label	Variable Name	Units
Dependent Vars.		
ptdl	Per capita transmission / distribution energy losses	Percentage
pgdp	Per capita GDP	US$
trade	Per capita electricity trade	Percentage
hdi	Human Development Index	Score
gini	GINI coefficient	Score between 0 and 1
Explanatory Vars.		
trfms	Total reforms index	Score out of 6
ipps	IPPs	0/1
reg	Regulator	0/1
unbldg	Unbundling	0/1
corp	Corporatisation	0/1
otpaccess	Open/Third Party Access	0/1
dprv	Distribution privatisation	0/1
reg*dprv	Interaction variable 1	Multiplicative term
ipps*otpaccess	Interaction variable 2	Multiplicative term
unbldg*corp	Interaction variable 3	Multiplicative term
pepc	Per capita electric power consumption	kWh
trpi	Transparency index	Composite index
poic	Per capita installed capacity (minus hydro capacity)	KW
phic	Per capita hydro capacity	KW
pr	Political freedom (Freedom House Index)	Score 1-7
cl	Civil liberties (Freedom House Index)	Score 1-7
popn	Population	Millions
pre	Per capita total installed capacity	KW

Source: Authors

5. Results and Discussion

The results from our analysis are presented in Tables 4-7.[39] Our results are largely consistent across the GMM and 2SLS estimations conducted for each hypothesis.

5.1 Technical Impact

The expected outcome of the 'textbook' model of reform would be a positive technical impact as postulated by our first hypothesis. Our results are not always unambiguous. Two variables – per capital electric power consumption and corporatisation – appear to have significant associations with transmission and distribution losses, as seen in Table 4. Higher per capita electric power consumption is associated with a higher rate of transmission and distribution losses, which is an expected impact. Our results show that corporatisation is the only reform measure to have had a significant impact. They also show that corporatisation by itself appears to have had a more distinctive impact than unbundling and corporatisation together, for the reduction of transmission and distribution losses.[40] Although unbundling constitutes, as a minimum, the 'accounting separation' of utilities, the incorporation under company law of utilities through corporatisation facilitates greater accountability over commercial and technical losses. In comparison, existing econometric studies performed on global data, fail to arrive at a consensus. For example, Nagayama (2007) finds that reform measures including IPPs, unbundling and regulation led to lower T&D losses, while Smith (2004) finds that T&D losses increased after reforms in many developing countries. The global data used may have lacked robust controls for contextual and institutional factors (both shared and different)[41], and our focus on non-OECD Asian developing economies inherently controls for some of this heterogeneity (in addition to the control variables included in our estimations).

Table 4: Technical Impact of Reforms

	L.PTDL	
	GMM	**2SLS**
IPPS	0.089	0.063
	(0.20)	(0.29)
REG	0.033	0.039
	(0.04)	(0.044)
UNBLDG	-0.032	0.002
	(0.06)	(0.063)
CORP	-0.145***	-0.145*
	(0.06)	(0.08)
OTPACCESS	-0.012	0.015
	(0.19)	(0.27)
DPRV	0.149	0.614
	(0.44)	(0.62)
L.PEPC	0.632***	0.65***
	(0.06)	(0.06)
L.TRPI	0.04	0.036
	(0.14)	(0.15)
REG*DPRV	0.0007	0.09
	(0.43)	(0.60)

[39] See Appendices for post-estimation tests and descriptive statistics.

[40] For instance, Sen and Jamasb (2012) considered the effects of unbundling carried out in the early stages of reform and found that performance measures tended to worsen rather than improve.

[41] Nepal and Jamasb (2012) in an econometric analysis of 27 transition countries find that power sector reforms on their own did not produce significant effects on T&D losses, implying that institutional factors matter.

IPPS*OTPACCESS	0.026	-0.007
	(0.18)	(0.27)
UNBLDG*CORP	0.033	0.002
	(0.07)	(0.062)
_CONS	3.47	3.29
	(0.62)	(0.44)
R^2	0.82	0.82
N	235	235

*/**/*** indicates significance at 10, 5 and 1% respectively

5.2 Economic Impact

Our second hypothesis postulated that electricity sector reforms should have led to positive impacts on economic growth - measured by per capita GDP and per capita electricity trade in separate estimations.

5.2.1 Per Capita GDP

The literature has generally shown a positive impact on economic growth, although the econometric studies which have postulated this have focused on large cross-country data without a specific geographic or contextual focus (with the exception of Nepal and Jamasb, 2012a; 2012b), or alternatively, country-specific studies (Sen and Jamasb, 2012). As seen in Table 5, the results for GDP generally support this finding for non-OECD Asian economies; corporatisation is seen as having a significantly positive association with GDP. Similarly, distribution privatisation is seen to have a positive significant association with GDP on its own; but in combination with regulation (as demonstrated through the interaction variable *[regulator*distribution privatisation]*) we observe that it is has a negative significant association with GDP. This result is different from the literature – for instance, Zhang and Kirkpatrick (2008) found no evidence that privatisation has been effective in combination with independent regulation and competition.

Conversely, the literature shows that the quality of regulation determines electricity market outcomes – Cubbin and Stern (2006) find that higher quality regulatory governance leads to positive outcomes. Our results may therefore be reflective of weaker regulatory frameworks. Indeed, the regulators in our dataset are not independent, and represent quasi-government agencies. It is plausible that a lack of independent regulation may have constrained the effectiveness of distribution privatisation. Our results are unsurprising as political economy factors in developing countries have, as discussed, tended to influence reform outcomes (Rufin, 2003; Victor and Heller, 2007). Open access on its own has a negative significant association with GDP, but in combination with the presence of IPPs, shows a positive significant association with GDP. When placed in the context of the largely resource-deficit developing countries, this is a plausible result – in India, for example, a chronic shortage of electricity has meant that, despite the implementation of open access through legislation, it has failed to be fully utilised in electricity provision. The control variables show strong positive significant associations with GDP – namely, a higher amount of installed capacity, and a larger transparency index (better functioning institutions) – are both associated with higher per capita GDP.

Table 5: Economic Impact of Reforms

	L.PGDP			**L.TRADE**	
	GMM	**2SLS**		**GMM**	**2SLS**
IPPS	0.842	0.78	**IPPS**	-0.609	-0.902
	(0.64)	(0.64)		(0.88)	(1.212)
REG	0.015	-0.012	**REG**	0.046	0.015

	(0.056)	(0.09)		(0.12)	(0.145)
UNBLDG	-0.173	-0.213*	**UNBLDG**	0.011	0.005
	(0.26)	(0.13)		(0.173)	(0.19)
CORP	0.429***	0.399***	**CORP**	-0.047	-0.215
	(0.14)	(0.16)		(0.20)	(0.29)
OTPACCESS	0.999	-0.98*	**OTPACCESS**	0.55	0.80
	(0.86)	(0.59)		(0.798)	(1.09)
DPRV	2.78**	2.68**	**DPRV**	-0.914	-1.57
	(1.30)	(1.36)		(1..88)	(2.60)
L.PRE	0.174***	0.196**	**L.POIC**	-0.75***	-0.723***
	(0.068)	(0.101)		(0.099)	(0.154)
L.TRPI	1.074***	1.02***	**L.PHIC**	0.055	0.081
	(0.210)	(0.282)		(0.052)	(0.066)
REG*DPRV	-2.74**	-2.60**	**L.TRPI**	1.834***	1.743***
	(1.25)	(1.31)		(0.29)	(0.314)
IPPS*OTPACCESS	1.056	1.12**	**REG*DPRV**	0.488	1.147
	(0.842)	(0.574)		(1.84)	(2.55)
UNBLDG*CORP	-0.147	-0.089	**IPPS*OTPACCESS**	-0.154	-0.38
	(0.31)	(0.127)		(0.78)	(1.093)
_CONS	1.24	1.24	**UNBLDG*CORP**	0.028	0.045
	(0.54)	(0.54)		(0.185)	(0.180)
			_CONS	3.35	3.60
				(0.58)	(0.63)
R^2	0.18	0.23	**R^2**	0.41	0.36
N	235	235	**N**	235	235

*/**/*** indicates significance at 10, 5 and 1% respectively

5.2.2 Electricity trade

Our results do not find a positive association with electricity trade from either the individual reform measures or the interaction variables, implying that reforms have not promoted regional electricity cooperation. Although well-functioning markets can aid regional market integration, cross-border electricity cooperation has predated reforms in most of our countries, occurring mostly through high level bilateral political engagement (Singh et al., 2015). In other hydro-rich regions, such as Latin America, bilateral efforts have graduated into market-oriented reforms, with firms eventually replacing political actors in greater market integration (Raineri et al., 2013). In fact, regional market integration in Latin America was undertaken to reduce the large price disparities between countries (Raineri et al., 2013). Our results show that the same effect has failed to occur in developing non-OECD Asia, despite the presence of several cross-border bilateral electricity initiatives.[42] One constraint has been the rise of resource nationalism over hydro reserves South Asia.[43]

Of the control variables – per capita installed capacity *less* hydroelectric installed capacity (*l.poic*) has a negative highly significant association with electricity trade implying that a higher amount of non-hydroelectric installed capacity is associated with lower electricity trade. This is consistent with our observation on chronic fuel-deficits in most of the countries in our dataset – constrained supplies of conventional energy have meant that they have not engaged in electricity exports on a large scale. The transparency index (*l.trpi*) has a highly significant and positive association with electricity trade, implying that stronger and more transparent institutions may lead to greater electricity trade.

[42] See Singh et al. (2015).

[43] Strahorn (2011) discusses these largely political constraints. Resource nationalism appears to be a constraint when hydro resources are opened up to foreign governments rather than private sector firms.

5.3 Welfare Impact

As discussed earlier, our third hypothesis attempts to investigate broader links between electricity sector reforms and welfare impacts, whilst controlling for the influence of 'other' factors through our econometric estimation.

5.3.1 Income disparity

The dependent variable is the Gini coefficient, which is a measure of income inequality between 0 and 1, with 0 representing perfect equality and 1 representing perfect inequality. The wider literature postulates and finds a relationship between infrastructure development and reduction of income inequality (Lopez, 2003; Estache, 2003; Calderon and Severn, 2004), and this has been applied to the case of access to electricity (Brenneman and Kerf, 2002; Leipziger et al., 2003; Khandker et al., 2012a). However, the literature postulates that in order for infrastructure expansion to reduce income inequality, it must result in improved access and/or enhanced quality particularly for low-income households. The key issue is therefore how infrastructure impacts access by the poor (Estache et al., 2000; Calderon and Severn, 2004). A direct effect of reforms on income inequality is their impact on prices for low-income households (Jamasb et al., 2015).[44] The Gini coefficient can capture both effects. Our results find that different reform measures have had different directions and impact on the Gini coefficient – as seen in Table 6. The presence of a sector regulator has a significant negative association with the Gini coefficient implying that on the whole, regulation has occurred alongside reduced income inequality in the countries in our sample.[45]

On the other hand, distribution privatisation is associated with an increase in income inequality. This is related to the notion that the implementation of reforms in the absence of excess capacity and lack of cost-reflective pricing will have led to higher prices following distribution privatisation.[46] This is supported by empirical literature (Nagayama, 2007; 2009; Sen and Jamasb, 2012) and reflects the more direct association between reforms and income inequality, in that reforms may have led to higher prices for low income households. However, as electricity tariffs continue to be implicitly subsidised across many developing Asian economies, and as distribution privatisation has only been implemented in 4 out of the 17 countries in our dataset, we cannot draw firm conclusions from this result.

Amongst control variables, per capita electricity consumption is associated with a higher Gini coefficient, thus implying higher income inequality. While at first glance this is a counterintuitive, it can be related to increased access to electricity – if higher per capita electricity consumption is not a consequence of increased electrification, it could be an indicator of income inequality, as it implies that the higher income groups consume more electricity. The literature appears to support this conclusion - for instance Khandker et al. (2012b) using cross sectional household survey data for India for 2005 found that a larger share of gains from rural electrification accrued disproportionately to wealthier rural households. Finally, the transparency index is associated with a positive (increasing) impact on the Gini coefficient. This implies that higher transparency occurs alongside an increase in income inequality. This is an analytically intractable result; however, it is plausible that improvements in transparency reveal the true extent of inequality in developing countries. A parallel can be drawn from the results in Sen and Jamasb (2012), which shows in an econometric analysis of Indian states that the outcomes of electricity sector reform tend to be adverse in the initial stages of reform, but improve beyond a threshold.[47]

[44] We were unable to obtain reliable time series data on electricity prices for the countries in our dataset.
[45] As a lower Gini coefficient signifies lower inequality. However, it is difficult to draw a link with electricity reforms in this regard, as this result could reflect regulatory intervention to prevent prices from rising, or conversely could reflect lump sum transfers to consumers made worse off by reforms and liberalisation.
[46] This is in contrast with the OECD experience, where reforms were implemented in a situation of excess capacity.
[47] This result may possibly have a temporal dimension, which is beyond the scope of this paper.

Table 6: Welfare Impact of Reforms

	L.GINI			L.HDI	
	GMM	**2SLS**		**GMM**	**2SLS**
IPPS	1.208	1.219	**IPPS**	0.12	0.095
	(1.41)	(0.948)		(0.25)	(0.087)
REG	-0.245	-0.248	**REG**	-0.081*	-0.045*
	(0.315)	(0.25)		(0.05)	(0.024)
UNBLDG	-0.123	-0.125	**UNBLDG**	-0.12	-0.053
	(0.181)	(0.36)		(0.25)	(0.056)
CORP	0.080	0.082	**CORP**	-0.06	-0.019
	(0.16)	(0.224)		(0.08)	(0.027)
OTPACCESS	-0.70	-0.707	**OTPACCESS**	-0.09	-0.022
	(0.82)	(0.485)		(0.06)	(0.084)
DPRV	0.95	0.956	**DPRV**	0.273*	0.143*
	(1.18)	(0.83)		(0.15)	(0.08)
L.PEPC	0.208	0.209	**L.PEPC**	0.12***	0.037
	(0.179)	(0.15)		(0.096)	(0.023)
L.TRPI	0.015	0.019	**L.TRPI**	0.055**	0.30***
	(0.524)	(0.60)		(0.052)	(0.083)
REG*DPRV	-	-	**REG*DPRV**	-	-
IPPS*OTPACCESS	-	-	**IPPS*OTPACCESS**	-	-0.017
					(0.073)
UNBLDG*CORP	0.158	0.161	**UNBLDG*CORP**	0.16	0.062
	(0.234)	(0.344)		(0.28)	(0.058)
_CONS	-3.72	-3.74	**_CONS**	-	0.94
	(3.12)	(2.05)			(0.27)
R^2	-	-	**R^2**	-	-
N	75	75	**N**	59	59

*/**/*** indicates significance at 10, 5 and 1% respectively

5.3.2 Human Development Index

In our results, we do not find direct significant impacts of electricity sector reform on the HDI. Arguably, the evidence is weak at best. A graphical depiction of the data shows a positive relationship between the HDI and per capital electric power consumption (see Appendices). The literature, as we have discussed, postulates and finds a link between electricity access and the HDI – for instance, Leipziger et al. (2003) explore the relationship between electricity access and educational attainment, which is one component of the HDI. Cross-country econometric studies have also found positive impacts from reforms on the quality of service and on access, particularly from regulatory governance and independent regulation (Cubbin and Stern, 2004; 2006, ESMAP, 2011; Zhang et al., 2005; 2008). The presumption would be that over two decades of electricity reforms may have had broader welfare impacts as measured directly by the HDI. However, according to our results, this has not occurred. Although there is an argument that textbook electricity reforms do not automatically enable access, and that access is instead provided through special targeted programmes, there is evidence in the literature that regulation has in some cases facilitated increased access. For instance, ESMAP (2011) uses panel data for 20 developing countries and shows that independent regulation increased access substantially. However, our dataset shows that regulation has not been independent in most non-OECD Asian developing countries, and that regulators have tended to be quasi – government organisation.

5.4 Additional Estimations

One purpose of electricity reform has been to attract private investment – the results from the first additional estimation show no strong evidence for the impact of reforms on total installed generating capacity. Our results do however show that the transparency index has a positive significant association with the dependent variable *l.pre* – implying that stronger institutions lead to more investment in installed capacity. Our results from a second additional estimation show that IPPs and distribution privatisation have been associated with increased hydro capacity, indicating that distribution utilities have contracted for power from hydro IPPs. For instance, Indian states such as Orissa which have relatively higher shares of hydro in fuel mix have aimed at expanding private sector hydro IPPs.[48]

However, the presence of a regulator, on its own, as well as in combination with distribution privatisation, shows a negative significant association with hydro installed capacity. This result also mirrors experiences in the countries in our sample. For instance, Nepal has one of South Asia's highest potential hydro capacity; economically feasible hydro power capacity is estimated at 40 GW. Yet, less than 1 GW of this capacity has been developed and this potential remains underutilised as the regulatory regime has constrained the entry of foreign state owned companies (such as in India). Further, hydro capacity reflects more complex regulatory issues as regulation is subject to administrative and political factors such as competing uses of water and the terms of water treaties – particularly when cross-border hydro resources are involved.

Table 7: Additional Estimations

	L.PRE			L.PHIC	
	GMM	**2SLS**		**GMM**	**2SLS**
IPPS	-1.53	-1.51	**IPPS**	7.40**	7.28*
	(1.17)	(1.22)		(3.26)	(3.97)
REG	0.15	0.079	**REG**	-1.01**	-0.96**
	(0.099)	(0.151)		(0.45)	(0.49)
UNBLDG	0.202	0.01	**UNBLDG**	-0.35	-0.262
	(0.36)	(0.20)		(1.09)	(0.67)
CORP	-0.243	-0.28	**CORP**	0.24	0.23
	(0.212)	(0.29)		(0.81)	(0.93)
OTPACCESS	1.66	1.43	**OTPACCESS**	-5.99	-5.84
	(1.25)	(1.12)		(5.11)	(3.97)
DPRV	-3.57	-3.30	**DPRV**	13.04*	12.79
	(2.39)	(2.60)		(7.21)	(8.50)
L.TRPI	2.36***	2.30***	**L.TRPI**	-0.68	-0.69
	(0.204)	(0.25)		(1.09)	(0.81)
REG*DPRV	3.28	3.07	**REG*DPRV**	-13.43**	-13.27*
	(2.30)	(2.50)		(6.78)	(8.15)
IPPS*OTPACCESS	-1.45	-1.20	**IPPS*OTPACCESS**	5.38	5.26
	(1.20)	(1.07)		(5.00)	(3.48)
UNBLDG*CORP	-0.28	-0.08	**UNBLDG*CORP**	0.88	0.79
	(0.39)	(0.20)		(1.28)	(0.65)
_CONS	5.87	5.90	**_CONS**	-2.52	-2.41
	(1.23)	(1.35)		(3.46)	(4.40)
R^2			**R^2**		
N	-	-	**N**	-	-

*/**/*** indicates significance at 10, 5 and 1% respectively

[48] See 'Odisha targets 129 MW in 12th Plan', *Business Standard*, 25 December 2013. Accessed from http://www.business-standard.com/article/economy-policy/odisha-targets-129-mw-hydro-power-in-12th-plan-113122500541_1.html

6. Conclusion

This paper has investigated the proposition from theoretical and empirical literature that the 'standard' or 'textbook' model of electricity reform has led to improved efficiency, higher economic surpluses, and the transfer of surplus to consumers. We assembled and used a new panel dataset covering 17 non-OECD Asian economies from 1990 to 2013. We assembled measures of electricity reforms along with appropriate control variables, to which we applied instrumental variables regression (while controlling for the presence of endogeneity) to test for the technical, economic and welfare impacts of reform.

Our results are subject to the limitations of data availability as with all econometric studies of this kind. There is therefore scope for extending the findings using case study analyses. First, our results empirically confirm the theoretical tension between economic and welfare outcomes – for instance, while regulation constrains the impact of measures such as distribution privatisation on economic growth, it has a positive impact on socioeconomic/welfare indicators. Similarly, privatisation of distribution networks has a positive association with economic growth, but a negative association with welfare indicators as it leads to rising prices. Second, our results also show that country-specific institutional factors have strongly influenced the reform outcomes in non-OECD Asia. This underscores the point that the uniform application of the standard model without reference to the inherent heterogeneity that characterises the countries in our dataset is unlikely to have resulted in the anticipated reform outcomes.

Our results have important policy implications. Competition in generation has helped to lower costs and introduce new capacity, albeit through badly-managed IPP programmes. This implies a much greater role for competition in order to meet public policy objectives, even when there are policy constraints related to final price levels. For instance, this could be through effective auctions to select new generation plants. Certain structural reform measures – particularly unbundling and corporatisation – have appeared to be successful in improving technical measures and economic impacts. It is evident that in many non-OECD developing countries, marginal costs were above average costs when liberalisation took place, implying that prices would need to rise in the first instance after liberalisation, and that governments were likely to intervene.

A rethinking of reforms would entail taking advantage of competition through the structural reform measures to lower system costs without raising average prices, or without raising prices to the poorest. If prices do need to rise to encourage the efficient use of electricity, other policy measures, such as fiscal transfers to poor consumers, would be needed to ensure that the surplus obtained from competition and liberalisation is transferred to poorer consumers, enhancing welfare. Our results therefore call for a renewed thinking, or a shift in focus of electricity reforms.

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Appendices

Post- estimation Tests

Variables	GMM	2SLS
LPGDP	endogenous*** and valid***	endogenous*** and valid***
LHDI	endogenous*** and valid***	endogenous*** and valid****
LGINI	endogenous* and valid*	endogenous** and valid**
LPRE	endogenous*** and valid*	endogenous*** and valid*
LPHIC	endogenous* and valid***	endogenous* and valid***
LPTDL	endogenous* and valid*	endogenous* and valid*
LTRADE	endogenous* and valid*	endogenous* and valid*

*/**/*** indicates significance at 10, 5 and 1% respectively

Correlations

	l.pgdp	l.ptdl	l.phic	l.pre	l.trade	l.gini	l.hdi	pr	cl	ipps	reg	unbldg	corp	otpaccess	dprv
L.PGDP	1														
L.PTDL	0.73	1													
L.PHIC	0.66	0.82	1												
L.PRE	0.76	0.89	0.65	1											
L.TRADE	0.19	0.05	0.18	0.08	1										
L.GINI	0.45	0.37	0.17	0.59	0.13	1									
L.HDI	0.58	0.50	0.39	0.69	-0.08	0.58	1								
PR	-0.22	0.01	0.05	0.16	0.24	-0.05	0.19	1							
CL	-0.27	-0.01	0.08	0.13	0.12	-0.08	0.23	0.91	1						
IPPS	-0.13	-0.10	-0.08	-0.09	0.02	-0.37	0.09	0.13	0.05	1					
REG	0.06	0.19	0.17	0.004	-0.04	-0.01	0.08	0.13	0.01	0.23	1				
UNBLDG	0.06	0.08	0.08	-0.11	-0.10	-0.08	-0.04	-0.20	-0.21	0.30	0.60	1			
CORP	0.29	0.21	0.18	0.02	-0.19	0.18	-0.03	-0.52	-0.50	-0.10	0.36	0.73	1		
OTPACCESS	0.55	0.41	0.21	0.39	-0.01	0.15	0.18	-0.56	-0.56	0.14	-0.08	0.29	0.34	1	
DPRV	-0.05	0.30	0.10	0.08	-0.20	0.10	-0.09	-0.42	-0.42	0.08	0.33	0.25	0.19	0.27	1

Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max	Observations
LPGDP	3.70	0.54	2.09	4.90	408
LPTDL	10.88	0.48	9.54	12.06	408
LPHIC	4.12	1.71	0.00	6.59	408
LPRE	5.24	0.63	3.77	6.41	408
LTRADE	0.24	0.73	-1.40	1.96	408
LGINI	1.58	0.07	1.44	1.80	82
LHDI	-0.18	0.29	-0.46	2.88	131
PR	4.85	1.81	2.00	7.00	408
CL	4.76	1.21	3.00	7.00	408
IPPS	0.78	0.42	0.00	1.00	408
REG	0.38	0.48	0.00	1.00	408
UNBLDG	0.37	0.48	0.00	1.00	408
CORP	0.57	0.50	0.00	1.00	408
OTPACCESS	0.13	0.34	0.00	1.00	408
DPRV	0.16	0.36	0.00	1.00	408

HDI and per capita electricity consumption