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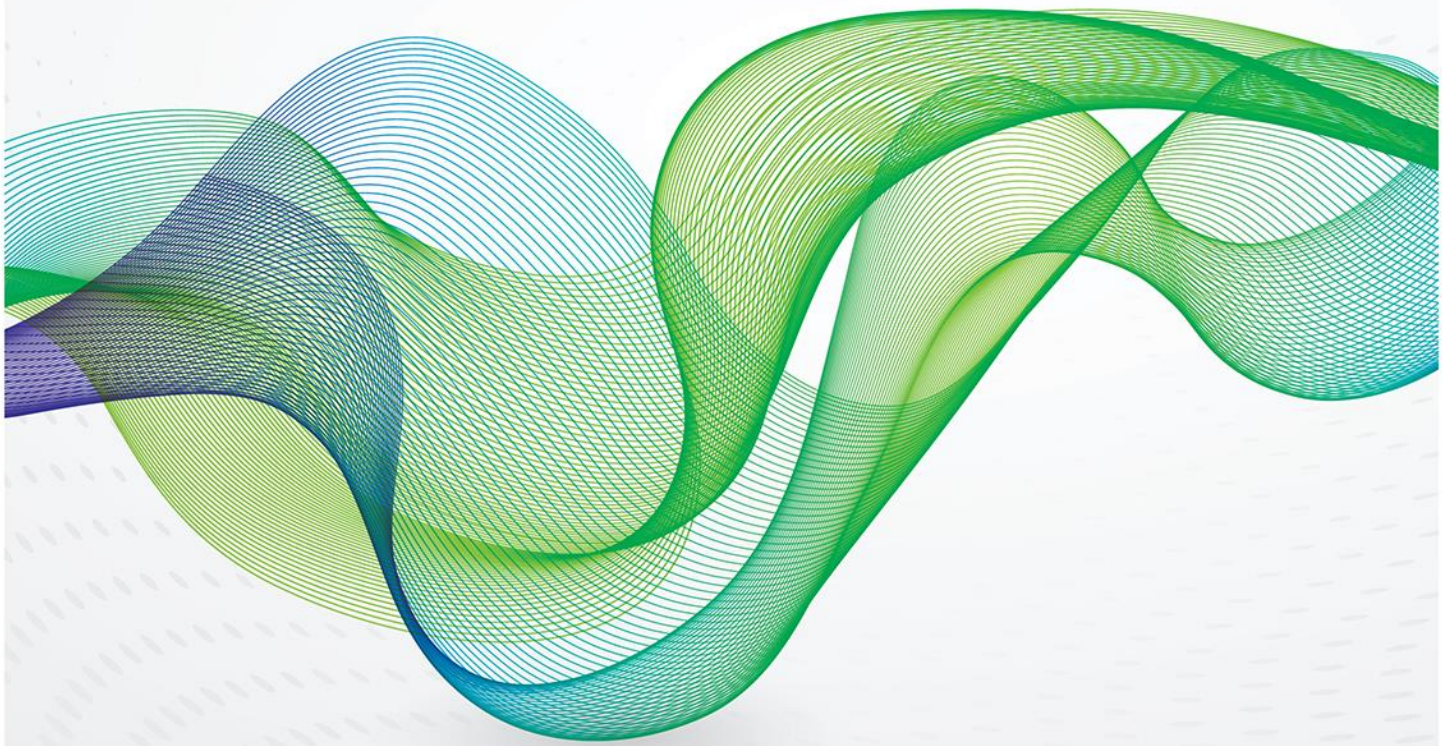
Reforming Electricity Reforms? Empirical Evidence from Asian Economies



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Contents

Figures

Tables

Reforming Electricity Reforms?
Empirical Evidence from Asian Economies

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Abstract

After more than two decades of attempts at electricity sector reform, there is a strong case for assessing empirical evidence on its outcomes, particularly for developing countries. Electricity reform programmes, implemented through the 'standard' or 'textbook' model, have their foundations in standard microeconomic theory and are based on the rationale that restructuring towards greater competition can lead to higher efficiency, maximise economic welfare, and transfer surplus to consumers. In practice, this has not always been the case, even in the OECD economies which pioneered the standard model. This paper investigates the outcomes of the standard model for developing countries, by applying instrumental variable regression techniques on an original and previously untested panel dataset covering 17 non-OECD developing Asian economies spanning 23 years. In contrast with the theoretical literature, our results show a tension between wider economic impacts and welfare impacts for consumers: namely, the variables that are associated with a positive effect on economic growth appear to be associated with a negative impact on welfare indicators. Our results show that institutional factors have influenced the outcomes, underscoring the point that the uniform application of the standard model without reference to the heterogeneity of the countries is unlikely to have resulted in originally intended outcomes. Our results call for a renewed thinking, or 'reform' 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 arguably undergoing a period of introspection following more than two decades of liberalisation and market-oriented restructuring. While this is partially related to the emergence of sustainability and climate-related goals, it is also related to the effectiveness of the original 'textbook' or 'standard' model of electricity sector reforms in improving both economic and technical efficiency and social welfare.

The original 'textbook' model of reform, which was pioneered in the 1980s and 1990s by the major OECD economies - namely, the United Kingdom, Norway, Chile and the US, was targeted at improving the operational efficiency of utilities (and consequently, the electricity sector). It sought to do so through the implementation of cost-reflective pricing based on competitive wholesale and retail markets in generation and distribution, and the 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 their competitive (generation, distribution and retail supply) and monopoly (distribution, transmission and system operation) functions and the commercialisation of these functions;*
- *the enactment of electricity legislation;*
- *the establishment of independent regulation; and,*
- *the divestiture or privatisation of the competitive segments (generation and distribution) of the electricity sector.*[4]

The spread of the standard model of electricity sector reform in the developing world, particularly non-OECD Asia, was predicated on multilateral financial lending linked to structural adjustment programmes. However, in the OECD, reforms were implemented against the context of excess capacity and relatively stable institutions, with the aim of improving sector performance resulting in potentially lower consumer prices. Reforms in the developing countries of the non-OECD were in contrast implemented against the backdrop of chronic electricity shortages, weak institutional capacity, and complex political factors.[5] Consequently, the viability of this model for the institutional contexts of developing countries has been debated extensively in the literature (Sen, 2014; Nepal and Jamasb, 2012a, 2012b; Gratwick and Eberhard, 2008; Williams and Ghanadan, 2006; World Bank, 1993).[6] While distributional issues[7] are arguably higher priority in developing countries relative to the OECD countries, the underlying rationale for reforms postulates that restructuring towards greater competition can improve efficiency, maximise economic welfare and transfer surplus to consumers, leading governments to assume that the successful implementation of market oriented reforms would have addressed these issues to some extent (Jamasb et al, 2015).

[4] With some exceptions – Norway for instance undertook the full programme of reforms without privatisation, resulting in what has been evaluated as a relatively successful implementation of market reforms. This was an early indicator of the fact that institutional contexts had a role to play in electricity market reform outcomes. See Bye and Hope (2005) for an assessment of electricity market reform in Norway.

[5] Electricity policy was often influenced by corruption and patronage. See Victor and Heller (2007).

[6] However, the textbook model has arguably failed to yield higher surpluses through lower prices for consumers in several OECD countries as well.

[7] For instance, the lack of access to electricity.

Most Asian developing economies have struggled to achieve distinctively positive outcomes, despite adopting electricity reforms since the mid to late 1990s. The heterogeneity of institutional capacities amongst non-OECD countries implies that the outcomes of electricity sector reforms would be varied (Nepal and Jamasb, 2012a). Consequently, there is a strong case for reviewing the textbook model as it pertains to the developing economies of Asia, which are collectively poised to account for the largest increase in energy consumption over the next two decades.

The main aspect of the textbook model of reform being questioned in the OECD is its suitability in delivering low carbon electricity systems; and whether liberalized markets can integrate renewables, whilst also delivering the investments in backup generation that are required to support them.[8] However, while this remains an important element in reviewing electricity reforms in non-OECD developing Asia, the key area under focus is whether the textbook model has delivered efficiency and welfare impacts (in other words, the maximisation of not just total but also consumer surplus). South Asia accounts for 25 per cent of the world's total population but only 5 per cent of world electricity consumption. India, stated by the IMF as having overtaken China as the world's fastest growing economy in 2015-16[9], contains the largest number of people living below the poverty line in a single country (estimated at 300 million, or roughly a third of its population) with a considerable proportion subsisting on non-commercial energy sources.[10] Electricity demand in non-OECD Asia is predicted by the International Energy Agency to rise from 6,317 Terawatt hours (TWh) in 2012 to 13,982 TWh by 2035 in the New Policies Scenario (IEA, 2014). Meeting this demand will be a challenge for most developing non-OECD Asian countries. These issues merit a comprehensive empirical study of power sector reforms in developing Asia, with a view to its technical, economic and welfare effects, focusing on the gap between expected and actual reform outcomes. The paper addresses the following research question: to what extent have electricity sector reforms in non-OECD Asia led to expected outcomes from the textbook model of electricity reform?

While there is some cross-country literature on the effects of electricity reforms in developed and developing economies, there has been no systematic attempt thus far to examine their technical, economic and welfare impacts whilst accounting for cross-country institutional differences, for non-OECD Asian developing economies. This paper fills a gap in the literature in the following ways: First, to our knowledge, this paper is the first 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 data set on 17 non-OECD developing Asian economies, from 1990-2013, which allows 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. It should be noted that this paper focuses on empirical outcomes and evidence rather than normative questions, and investigates broader econometric associations rather than focusing on country-specific policy events, as the latter are better addressed by means of case study analyses. We aim to compare our findings with the state of existing knowledge on electricity reforms and liberalisation, to identify new learnings.

The remainder of the paper is structured as follows. Section 2 begins by describing the experience of electricity reform in non-OECD developing Asia. Section 3 sets out the theoretical rationale underpinning electricity reforms, highlighting the fact that there is no 'universal theory of reforms' but rather that reform programmes are rooted in standard microeconomics, and to comprehensively review and point out the gap in empirical literature, building up to the three main hypotheses. Section 4

[8] See Sen (2014) for a summary of the main points in this debate.
[9] India is estimated to have grown at 7.3. per cent in 2015/16, with economic growth in China slowing down to 6.9 per cent.
[10] Such as the burning of wood and waste.

describes the empirical method, data, and econometric estimation, followed by a discussion of results in Section 5. Section 6 concludes with policy implications.

2. Electricity Reform in Non-OECD Asia

In this section, we compare the experiences of the 17 non-OECD Asian countries against the 'milestones' of electricity reforms, highlighting the underlying complexities in contrast with that of OECD countries.[11] These economies accounted for 34 per cent of world primary energy demand (Million tonnes oil equivalent) in 2012, and that is forecast to grow to 41 per cent by 2040 (IEA, 2014). Total electricity generation (Terawatt hours) in non-OECD Asia is 33 per cent of world electricity generation, with non-OECD Asia carbon emissions (Million tonnes) forming 38 per cent of global emissions (IEA, 2014). Total installed capacity (Gigawatts) in non-OECD Asian economies comprises 30 per cent of global installed capacity, and is predicted to grow to 44 per cent by 2040 (IEA, 2014). The 17 countries in this analysis also represent over 60 per cent of the world's population. The scale of these numbers shows that the outcome of electricity reforms in these economies not only has direct implications for global energy use, but also for socioeconomic and welfare indicators, as Asia is home to two thirds of the world's poor population.

Williams and Ghanadan (2006) summarise the contrasting elements of electricity reform in OECD versus non-OECD countries. They show that while OECD electricity reforms were motivated by the desire to restructure the sector into its competitive functions following the breakdown of the historical 'natural monopoly' argument, non-OECD reforms were motivated more directly by narrower fiscal concerns and the need to address the precarious condition of public utilities' finances.[12] This is applicable to almost all of non-OECD Asia. Although the timeline and pace of electricity sector reforms in non-OECD Asian countries have differed, their experiences have been largely characterised by the same underlying problems – inefficiency, below-cost pricing (subsidies), high technical and commercial losses, and in some cases, high levels of theft. Although pockets of market-oriented electricity systems have emerged in some developing economies such as India, albeit under difficult circumstances (Littlechild, 2013), electricity reforms have remained a delayed and largely intermittent process in many of these economies.

Table 1 depicts the broad status of reform in 17 non-OECD Asian countries set against the standard model of reform which is typically used to assess 'milestones' in the reform process (Gratwick and Eberhard, 2008; Joskow, 2008; Victor and Heller, 2007). It should be noted that individual countries' experiences have tended to be characterised by their structural and institutional contexts, which are explored further in this section.[13] For instance, although India, the Philippines and Singapore have

[11] Non-OECD Asia is described by the International Energy Agency (IEA) as primarily including the following countries: Bangladesh, Bhutan, Brunei Darussalam (Brunei), Cambodia, China, Chinese Taipei (Taiwan), India, Indonesia, Laos, North Korea, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, Vietnam (IEA, 2014). Countries that are included for which IEA data is unavailable or unreliable include Afghanistan, Cook Islands, East Timor, Fiji, French Polynesia, Kiribati, Macau (China), New Caledonia, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga and Vanuatu. 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.

[12] One could argue that the power deficits, brownouts and lack of electricity access that were widespread problems across non-OECD Asian countries were symptomatic of these underlying concerns.

[13] For instance, reforms may have been implemented in federal systems of government in some countries –making the decision processes much more decentralized and hence fragmented, as opposed to centralized systems of government.

officially (in legislation) adopted all the elements of electricity market reform, India lags far behind in implementation; Singapore has successfully created wholesale markets and competition in retail supply while India has not.

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

	Independent Power Producers	*Regulator*	*Unbundling*	*Corporatisation*	*Open/Third Party Access*[14]	*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

2.1 Independent Power Producers

As depicted in Table 1, the entry of Independent Power Producers (IPPs) into the electricity generation sector has been the most widely adopted measure, with 16 out of 17 countries opting for IPPs. The experiences with IPPs (introduced mostly from the early 1990s onwards) have differed vastly, the determining factor of which has tended to be utilities' (and consumers') ability to pay relatively higher tariffs for electricity provided by IPPs.[15] For instance, in Malaysia, IPPs have evolved since their introduction in 1993 into a competitive business – Malaysia's second generation (post-millennial) IPPs have largely been procured through competitive tendering, and have reportedly contributed to the reserve margins of 23 per cent (Energy Commission, 2014).[16] However, these have resulted in relatively high consumer tariffs (which is not an unexpected outcome). In contrast, IPPs have had a less successful early history in India – with Enron's attempt to set up an IPP widely cited as the failure of India's 1991 effort to open up the power generation sector (Mukherjee, 2014).[17] Since these early

[14] Third Party Access has been implemented to varying degrees in these countries (see Section 2.4); however, in the majority it has been confined to the largest consumers.

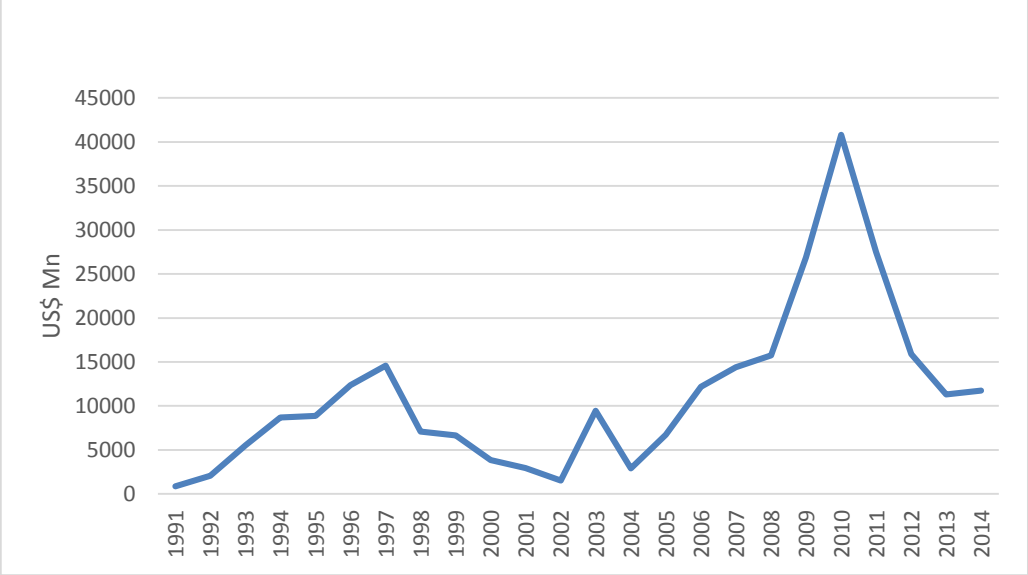
[15] Due to the fact that utilities have struggled to implement cost-reflective tariffs.

[16] Leading domestic IPP Malakoff has garnered a 25 per cent share in the generation market in peninsular Malaysia.

[17] Enron's early attempt to set up an IPP in India ran into significant problems, with allegations over excessively high tariffs in the Power Purchase Agreement with the State Electricity Board (which the Board allegedly could not afford to pay) leading to the state government of Maharashtra reneging on its agreement with Enron. After several years mired in expensive litigation, Enron

failures and the implementation of further reforms to open/third party access, IPPs in India have provided a functional alternative to the lack of public sector capacity additions in recent years. The Indian government's planned programme of adding supercritical coal-fired generation plant capacity through 'Ultra Mega Power Plant' projects[18] have faced similar issues with tariff levels and the economic viability of distribution utilities to purchase power from IPPs. These issues have been partially resolved through the increase of low-cost domestic coal production and the auctioning of domestic coal supply linkages to IPPs.[19]

Figure 1: IPP Investments in Asia, 1990-2014



Source: World Bank PPI Database[20]

Pakistan constitutes another example wherein after an initial period of optimism, disappointment set in. By 1998 IPPs representing two thirds of private power capacity contracted were plagued with allegations of corruption, technical inconsistencies and attempts by the government to renegotiate tariffs (Fraser, 2005). Setting a bulk tariff ceiling allowed Pakistan to alleviate its power shortage through private generation in record time; however, too much power was contracted with little regard for least-cost expansion (Fraser, 2005).[21] More generally, Pakistan's IPP problems have been intertwined with its circular debt crisis in the power sector, stemming from the inability of distribution utilities to pay for electricity, as they do not recover their cost of supply from tariffs (Kessides, 2013).

In Indonesia and the Philippines, IPPs were introduced in the early 1990s in an effort to resolve the problem of electricity shortages: by 1997, the Philippines had successfully contracted 37 IPPs

exited the project, shortly before its own financial collapse. The project has since been taken over by a public consortium, which is still struggling to revive it to its originally envisaged full capacity. See Mukherjee (2014) for a discussion of private participation in generation in India and the Enron experience and Sant and Dixit (1995) for arguments in favour of the cancellation of the project at the time.

[18] The details of this programme can be found at http://powermin.nic.in/upload/pdf/ultra_mega_project.pdf

[19] The Indian government in 2014/15 carried out a series of 'reverse auctions' for coal to IPPs. This has been criticised as an unsustainable solution from the point of view of climate/environmental goals, as it encourages the use of coal.

[20] Data includes all countries in our dataset apart from Brunei and Singapore. The data is graphed according to the year of financial closure.

[21] See Fraser (2005) for a detailed account of the failure of IPPs in Pakistan, and the World Bank Group's attempts to restore collapsed agreements between the IPPs and the government.

representing 40 per cent of generation capacity. However, following the Asian financial crisis most of these IPPs had to be renegotiated, essentially returning these countries to power deficits. Wu and Sulistiyanto (2013) argue that the spate of renegotiations in the aftermath of the Asian financial crisis uncovered allegations of patronage in the awarding of IPP contracts in both countries, as well as public opposition over rate hikes, highlighting the importance of institutional contexts in the implementation of reforms. The history of IPPs in Thailand (where the power sector is highly dependent on gas), which were introduced in 1992 along with generation privatisation, followed a similar path, eventually stalling the process of electricity reforms (Wu, 2005a). Singapore remains one of the few non-OECD Asian countries to have achieved liberalised markets in electricity and successfully incorporated IPPs. However, IPPs have led to a situation of oversupply, which combined with high gas take-or-pay arrangements have driven market prices down to short-run marginal cost, potentially deterring future investment in new capacity (Somani and Lim, 2014). Continuous improvements in market design, such as the setting up of a futures market in electricity in 2015, are being undertaken in an effort to resolve the investment problem.

Among smaller countries, Laos, Bhutan and Nepal have significant hydropower potential, some of which has been developed through IPPs. The obvious advantage of hydro-based IPPs is lower tariffs through significantly mitigated fuel costs relative to fossil fuel-based electricity; however, in Bhutan and Nepal, concerns over property rights and sovereignty over natural resources have prevented or slowed the development of hydropower IPPs.[22]

Bangladesh has been open to IPPs since 1996, and around a third of total generation capacity is under private sector operation. Cross border trade agreements with India have led to investments in expanding network infrastructure, and further potential for IPP based power – however, investment in IPPs in recent years has slowed, partially due to a reorientation of multilateral financial institutions towards financing clean energy, and a general lack of interest from investors. Myanmar, a potentially gas-rich country, enacted liberalised foreign investment legislation in 2012, which has since led to a spate of Power Purchase Agreements (PPAs) with IPPs; these have yet to move forward, given Myanmar's recent re-entry into world markets since the easing of sanctions. Similarly, Vietnam opened its power sector to IPPs in the early 2000s, but uncertainty in the provision of foreign exchange guarantees has stalled private sector project development efforts.

In Sri Lanka, IPPs were adopted in 1992, and private sector generation has grown to represent over 40 per cent of electricity demand met, from a combination of small hydro and fossil fuel facilities. However, the lack of domestic resources implies that Sri Lanka's IPPs will need to increase their reliance on imported fuels, with implications for cost of supply and power tariffs. In China, also a country with an early history of IPPs (controlled private investment in generation began in the mid-1980s), the introduction of IPPs selling to a single buyer in the province (the regional or provincial power bureau) was considered the least disruptive way of introducing competition, as this would not change the basic structure of the vertically-integrated power market (Wu, 2005b). As a result of poor network infrastructure, each provincial/regional power grid typically constituted an 'isolated market'. Capacity surpluses could not be spread (through inter-provincial exports) to areas in need of power, making IPPs highly susceptible to regional fluctuations in supply and demand, and this has been a key factor affecting investment outcomes (Wu, 2005b).

Thus, although IPPs have been the most popular and widely implemented element of electricity sector reform in non-OECD Asian countries, this was mostly because they were often the quickest and easiest way to introduce some element of competition without extensive restructuring. Moreover, IPPs were

[22] For instance, negotiations between the Nepalese and Indian governments over Indian investment into developing Nepal's hydropower infrastructure have been plagued by public protests citing concerns over the acquiescing of Nepal's national sovereignty over its hydro resources.

introduced through a wave of popularity worldwide in the early 1990s. In adopting IPPs, the investment risk was transferred to utilities and in some cases ultimately consumers (through higher tariffs) through the 'take or pay' clauses prevalent in many contracts (such as Indonesia and the Philippines) –some countries coped by evolving their electricity markets to adapt to this risk, but most struggled to harness IPPs in a way that best fitted with their respective fiscal and institutional contexts.

2.2 Electricity Regulator

The establishment of an electricity regulator occurred at a relatively later stage of reforms – the early to mid-2000s – for most non-OECD Asian countries. A major impediment to effective regulation has been the highly politicised nature of electricity within their different institutional contexts, implying that regulators often struggle to implement reforms such as tariff revisions (increases) (Rufin, 2003). Fifteen out of seventeen countries in our dataset (Indonesia and Laos being the exceptions) have established some type of regulator – either (theoretically) independent of government, or a distinctive body housed within government/ministerial organisations. India and Pakistan were the earliest adopters of regulation, in 1997. Pakistan established the National Electric Power Regulatory Authority (NEPRA), which was tasked with developing a regulatory framework which ensured "the provision of safe, reliable, efficient and affordable power".[23] India passed legislation in 1998 enabling the establishment of independent State Electricity Regulatory Commissions (SERCs).[24] India's SERCs receive submissions on utilities' annual revenue requirements and hold public hearings debating the economic viability of the same before passing tariff orders. However, regulators in both countries have struggled to implement cost-reflective pricing in distribution, with the central government often bearing the fiscal consequences.[25]

China's approach to regulation has been somewhat different – although the State Council issued regulations from the early stages of reform (1980s and 1990s), the official regulator, State Electricity Regulatory Commission, was set up in 2002 to oversee issues such as the pricing of electricity, and issuing and managing electric power business permits.[26] In order to protect important national objectives such as health and safety, and environmental and consumer protection, China continues to extend the regulatory framework to other energy-related sectors such as renewables (Ngan, 2010). China also introduced competition rules for mitigating market access barriers and ensuring more competitive outcomes in partially liberalised energy markets, where only a segment of the energy supply chain is open to competition (Ngan, 2010). Thus, although China's regulator remains within the ambit of the government, its regulatory approach has been aimed at consolidating electricity regulation with other energy-related industry sectors.

Bangladesh's Electricity Regulatory Commission (BERC) was established around the same time as China's (in 2003), with the specific mandate to "create an atmosphere conducive to private investment" amongst other goals such as promoting consumer protection, competition and transparency. The Commission was established to make provisions for the establishment of an independent and impartial regulatory commission for the energy sector. The BERC is therefore a quasi-government body with the mandate to exercise judicial authority on matters related to electricity.[27] Malaysia established an Energy Commission in 2001, which became fully functional in 2002. The Commission is a statutory body responsible for regulating the energy sector, particularly the electricity supply and piped gas supply industries in Peninsular Malaysia and Sabah, and has the mandate to "ensure that the supply of

[23] See www.nepra.org.pk
[24] The Electricity Regulatory Commissions Act, 1998, which was later superseded by the Electricity Act, 2003.
[25] See Pargal and Banerjee (2014) for a discussion on India's distribution utilities.
[26] The Commission remained under the purview of the NDRC Energy Bureau, which retains residual powers over most aspects of electricity policy.
[27] See www.berc.org.bd

electricity and piped gas to consumers is secure, reliable, safe and at reasonable prices."[28] The Philippines Electricity Regulatory Commission (ERC) was established through legislation in 2001, as an independent, quasi-judicial regulatory body which replaced the previous Electricity Regulatory Board. The ERC's mandate is to "endeavour to create a regulatory environment that is democratic and transparent, and one that equitably balances the interests of both the consumers and the utility investors."

Thailand's Electricity Regulatory Commission (ERC) was established in its Energy Act of 2007 – and by definition it is a quasi-government body. The Energy Act prescribes the role of the ERC to ''promote competition in the energy industry and prevent abusive use of dominance in the energy industry operation and to promote fairness and transparency of the service provision of the energy network systems, without unjust discrimination" (Wisuttisak, 2012). However, Thailand's electricity sector has been dominated by state-owned enterprises, and the Energy Act somewhat contradictorily tasks the ERC with 'supporting' the position of these enterprises. Thus, although the ERC was tasked with engendering competition in the sector, institutional problems, alongside a sometimes volatile political environment, have impeded the progress of reform.

Singapore, amongst the most advanced in reforms of the non-OECD countries in our dataset with its National Electricity Market, established the Energy Market Authority (EMA) in 2001- the EMA consists of an industry regulator and a system operator. By 2008, the market had been liberalised to a large extent, with competition in generation and retail supply, but with the exception of a segment of 'non-contestable' consumers. Due to concerns over market power in generation, one of the main functions of the EMA is to regulate 'vesting contracts', introduced in January 2004 – these are bilateral electricity agreements between generation companies and market support services licensees[29] which require generation companies to sell a set amount of electricity at a specified price. This policy limits the ability of the larger generation companies to exercise market power via withholding their capacity during scarcity periods to push up wholesale spot prices (Chang and Li, 2013). In the Philippines, also fairly advanced in electricity market reform (Nagayama, 2007), the Energy Regulatory Commission was established as part of reforms legislated in 2001 to ensure a transparent, competitive, and reliable electricity market (Santiago and Roxas, 2010). Although the elements of market reform were introduced in electricity legislation, the regulator has struggled to deal with the highly politicised issue of tariffs, and with the mitigation of market power, which is predominantly exercised by government utilities.[30] New entrants into the Philippine electricity market have in the past complained about market outcomes and what they perceive as market abuse by government-owned generation players (Santiago and Roxas, 2010).

Amongst smaller non-OECD Asian economies, Bhutan's Electricity Authority was established in 2001, to "restructure and regulate the electricity supply industry, to allow private sector participation in the electricity supply industry based on the policy approved by the Royal Government of Bhutan and to empower the Royal Government to create companies for carrying out all or any of the purpose of the [electricity] Act."[31] It became a fully autonomous body in 2010. Similarly, Maldives Energy Authority, established in 2006, is described as an independent regulatory authority affiliated to the ministry of energy and environment, which operates under a governing body appointed by the President. Unlike Bhutan, which utilises electricity produced from hydro resources, Maldives utilises imported petroleum products (primarily diesel) for electricity and thus its regulator has an important advisory role in relation to the country's trade balance. Notably, Maldives has a new energy policy which explicitly aims at

[28] See www.st.gov.my

[29] Which provide metering and billing services to consumers. See Chang and Li (2013) for an analysis of Singapore's electricity market reform.

[30] Signifying problems with both public ownership and a lack of competition.

[31] See www.bea.gov.bt

achieving carbon neutrality in the energy sector by 2020, given the country's vulnerability to climate change impacts. In Sri Lanka, the Public Utilities Commission of Sri Lanka was established as the regulator for the water and electricity sectors in 2003. Its role in each segment of the electricity sector was clarified further following Sri Lanka's Electricity Act in 2009. In Nepal, the Nepal Electricity Regulatory Commission was proposed in 2001 in its new hydropower development policy; this was to replace the Electricity Tariff Fixation Commission. Legislation (Nepal Electricity Regulatory Commission Bill) was drafted in 2007, but has yet to be implemented. Myanmar was among the last adopters of regulation; in 2013 it drafted legislation enabling the creation of an electricity regulator but this has yet to be implemented.

All of the countries in our dataset except one (Brunei) have (or have drafted legislation to constitute) a distinctive body that operates as electricity regulator; however, in most cases this is not an autonomous or independent organisation from government. Experiences with regulation have also been varied – but generally, in countries where electricity market reform is as yet underdeveloped, the main issue faced by regulators relates to reforming tariffs to reflect costs. In countries where markets have developed to more advanced structures, the main regulatory issues have been related to mitigation of market power, and in many cases this is still exercised by (formerly monopolistic) state-owned companies.

2.3 Unbundling and Corporatisation

Unbundling implies the structural and functional separation of the business of electricity production and supply into its competitive (generation and retail supply) and non-competitive (distribution and transmission) components. While unbundling implies the separation of accounting, corporatisation refers to the formal commercialisation of unbundled entities or their incorporation as commercial businesses under Company Law – essentially, corporatisation mandates economically rational operational decisions (as opposed to politically motivated decisions). Although the logic of reform from public sector to market driven processes would imply that corporatisation follows unbundling, actual experiences with both have vastly differed in non-OECD Asia. Four countries in our sample – Brunei, Laos, Myanmar and Sri Lanka – have retained vertically integrated public sector monopolies. One (Maldives) – has a corporatized, vertically integrated monopoly (State Electric Company Limited or STELCO) which is wholly owned by the government.[32] The common factor amongst these five countries is that they have relatively small power systems which may account for the absence of unbundling and corporatisation; Nepal and Jamasb (2012b) argue that in smaller systems, the creation of an independent regulatory authority may be more important than the unbundling of the system, particularly in cases of politically unstable countries and especially for the case of countries where hydroelectric power is predominant.

Contradictory to the 'logical' reform sequence, most of the countries in our sample corporatized prior to unbundling, which in some cases took place several years after corporatisation. For instance, China created the State Power Corporation of China (SPCC) in the late 1990s to take over the enterprise management functions from the Ministry of Electrical Power, and the provincial and lower level power bureaus were renamed as companies within the SPCC (Andrews-Speed, 2013). The wholly state-owned SPCC retained almost all the transmission infrastructure and 50 per cent of the generation infrastructure – with the rest owned by a wide variety of state-owned enterprises linked to different levels of government (Andrews-Speed, 2013). In 2002, the SPCC was finally restructured into five generating companies, two grid companies, and a number of service companies. Distribution was not separated from transmission and the function of dispatch was not separated from grid ownership (Andrews-Speed, 2013). In 2015, China was in the process of extending a pilot programme which gives local authorities

[32] STELCO operated as a government department until 1997.

more control over transmission and distribution prices, with plans to further deregulate electricity provision to commercial and industrial users. These reforms require the two grid companies to eventually segregate their transmission and distribution business, which is expected to take a number of years (Reuters, 2015).[33]

Similarly, Singapore gradually deregulated its electricity market from a vertically integrated monopoly to a fully divested generation sector with competition in the wholesale market and retail electricity sectors, and a monopoly in the transmission and distribution sector (Chang and Li, 2013). Corporatisation of the government-owned Public Utilities Board's gas and electricity undertakings took place in 1995, whilst vertical separation and retail market liberalisation only occurred much later, in the early 2000s. Currently, Singapore has 12 competing generators, and seven competing retailers (Chang and Li, 2013). In the Philippines, the state owned corporatized monopoly National Power Corporation was unbundled following the Electric Power Industry Reform Act (EPIRA) in 2001. The Act called for the setting up of a Transmission Company to take over the function of network operation, and the privatisation of the assets of the National Power Corporation (including the Transco).[34] Vietnam's state owned vertically integrated company was corporatized in 1995; legal unbundling began over a decade later, in 2009, when Electricity Vietnam (EVN) unbundled into a separate transmission company. However, the government retains ownership over most of the entities in the electricity sector.

Countries where corporatisation followed unbundling include India (where each occurred within a year of the other), Pakistan (where both occurred simultaneously) and Bangladesh (where there was a lag of 6 years). The first instance of unbundling in India occurred during the reform of Orissa's electricity sector; this was followed by other state-level efforts at reform and eventually legislated for at the national level in India's landmark 2003 Electricity Act. Pakistan's Water and Power Development Authority (WAPDA) was unbundled and corporatized in 1998 (the Pakistan Electric Power Company (PEPCO) was set up to manage the unbundling process), creating four generation companies, eight distribution companies and the National Transmission and Dispatch Company which acts as a single buyer and is responsible for the transmission network. Bangladesh carried out a limited form of unbundling in 1995/1996, with the creation of Power Grid Company of Bangladesh Ltd. and the Dhaka Electricity Supply Company. Vertical unbundling continued through the 1990s and early 2000s, with the establishment of generation and distribution companies.

The experience in non-OECD Asia shows that although the majority of countries have implemented unbundling and corporatisation, public sector provision continues to dominate, particularly in the absence of competition in distribution and retail supply. Moreover, despite accounting separation, the finances of distribution companies in many of these countries remain precarious.

2.4 Open or Third Party Access

Open access to the grid is arguably a fundamental enabling factor of reform, as it facilitates competition in generation and distribution. Open access, or third party access, implies two basic features: the first involves consumers of public sector utilities being permitted to opt out of receiving supply from those utilities. The second feature involves consumers as well as private sector generation and distribution utilities being able to access network infrastructure that has typically been dominated by public sector utilities. As evident from Table 1, open access has been implemented in five out of the seventeen countries in our sample. In India, open access was implemented independently by a few states in the late 1990s/early 2000s – this was primarily to facilitate captive generation, which was adopted as a

[33] See Dupuy et al (2015) for an analysis of 'Document 9' which details China's plans for institutional reforms in the power sector.
[34] See Santiago and Roxas (2010) for a detailed account of electricity market reform in the Philippines.

temporary solution by industrial consumers to power shortages affecting their operations. Open access was institutionalized in India's 2003 Electricity Act. However, the main impediment to its implementation has been the imposition of 'surcharges' by some public network utility companies on large industrial consumers to compensate for the loss in revenue.[35] Despite this, open access has allowed pockets of market oriented systems to emerge. Indonesia has also had a rocky history with open access (and with electricity reforms in general). Comprehensive electricity reform legislation to liberalise all segments of the electricity sector was passed in 2002, but was ruled unconstitutional. The sector remained dominated by public ownership and operation until limited private sector participation began to be allowed from 2005 onwards. Indonesia's 2009 Electricity Law allowed full private participation in the supply of power for public use and open access for generation and distribution. However, the Law still provides Indonesia's state-owned electricity company – PLN, with priority rights to conduct its business throughout the country, and as the sole owner of transmission and distribution assets, PLN remains the only business entity involved in transmission and distribution. Private participation has therefore been largely limited to the generation sector.

In Thailand, despite efforts in the 1990s to liberalise wholesale and retail markets, political upheaval and influence have led to a form of quasi open access. Public sector companies operate geographically segregated oligopolies as well as hold majority shares in private generation companies, with the result that open access has had limited success in engendering competition.[36] The Philippines, with a comparatively long history of electricity market reforms, has had limited success with open access, as the structure of the industry closely resembles a private monopoly as opposed to a public monopoly. Open access and subsequently competition in retail supply has not led to lower electricity prices – this is partially due to fuel supply problems and a gradual move from coal to gas fired power, much of which will need to be from LNG imports.[37] Singapore, arguably the region's most advanced electricity market, has successfully implemented open access; 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. The contestable consumers can purchase electricity from an electricity retailer, indirectly from the National Electricity Market of Singapore (NEMS) through the Market Support Services Licensee (MSSL), or directly from the NEMS provided they are registered and allowed to trade in the NEMS (Chang and Li, 2013). Non-contestable consumers (domestic and small industries) whose monthly demand is < 10,000 kWh are serviced by the MSSL under regulated tariffs (Chang and Li, 2013).

2.5 Distribution Privatisation

Only four countries in our sample: 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 essentially resembled the switch from a public to a private monopoly. The country's National Power Corporation (NPC) controls the majority of electricity production through direct ownership shares in generation companies or through long term contracts with IPPs. The national transmission company controls the 'wires' through which electricity is delivered from the generation companies and IPPs to the distribution utilities, each of which delivers supply to retail consumers in its monopoly franchise area (Blank et al, 2012). While in the Philippines and Singapore distribution privatisation has been the outcome of sequential efforts towards electricity market reform, in Brunei and India the experience has been less structured.

[35] Industrial consumers essentially cross subsidise agricultural consumers; hence in the absence of tariff reform, open access has serious financial consequences for public utilities.
[36] See Wissutisak (2012) for a description of the Thai experience of electricity market reform.
[37] Fuel costs may feed through to higher prices, which are therefore not the consequence of liberalisation.

The Berakas Power Management Company in Brunei is a private limited company that owns and operates distribution substations and networks. In India, distribution privatisation has been implemented in two states. In Orissa, the privatisation was carried out in 1996 as part of World Bank reforms and was deemed to be largely unsuccessful as it was carried out without any restructuring or financial reform – effectively converting a public monopoly into a private monopoly. Delhi was the second state to privatise its distribution utilities in 2002; this 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 between private utilities and consumers.[38] The main opposition to distribution privatisation in India stems from concerns (from the public and politicians) over tariff increases.[39]

To summarise, electricity reforms in non-OECD Asia have happened in fits and starts, particularly in their progress through the full 'scorecard' that has been typically used in assessing the adoption of the textbook model. Further, the public sector continues to play a prominent role in most of the countries in our sample, combined with partial liberalisation. The experience also shows, at least at a qualitative level, that non-OECD Asian developing countries in our sample share characteristics with regards to their socioeconomic and political contexts. In the next section, we review existing evidence on the impact of reforms in developing countries; particularly on broader socioeconomic and welfare indicators.

3. Review of Reform Literature

3.1 Theoretical Underpinnings

There is no universal theory of 'reforms and restructuring'; however, much of the underlying logic for electricity reform has its foundations in microeconomic theory, and in industrial organisation, in which a fundamental objective is the maximisation of economic welfare. A combination of theoretical developments, technological advancements in the electricity industry, and political/ideological drivers have arguably underpinned the rationale towards electricity reforms and restructuring.

Although standard microeconomic theory shows that welfare (consumer + producer surplus) is maximised under conditions of perfect competition whereas monopoly could lead to a deadweight loss, the organisation of the electricity industry has evolved alongside the evolution of its specific technical/technological characteristics, which includes elements of natural monopoly. In the decades prior to the 'wave' of reforms and restructuring that began around the 1980s, the industry was seen as best organised around conditions leading to increasing returns to scale and cost efficiencies to be realised by a monopoly market structure (Steiner, 2000).[40] Under private ownership, a profit-maximising monopolist could charge prices that exceed marginal cost, resulting in deadweight losses so governments instituted public ownership under the assumption that state-owned companies would not maximise profits, leading to greater consumer welfare (Steiner, 2000). An alternative to this was regulated private monopoly, which however presented the usual problems of informational asymmetry (Armstrong and Sappington, 2006).

[38] Delhi is also a special case as it is a predominantly urban state and thus has no agricultural consumers.
[39] Largely because prices prior to privatisation were below costs.
[40] For instance, as the number of consumers supplied by a utility increased, reserve margin requirements decreased because the grouping of heterogeneous consumers effectively pooled the risk faced by the supplier, and as a consequent, operating and capital costs were expected to decrease (Steiner, 2000). Further, duplicative fixed costs of production could be avoided (Armstrong and Sappington, 2006).

Regulated public monopoly arguably presented advantages in terms of facilitating government policy on income redistribution and universal service goals[41]. However, the trade-off was the risk of regulatory capture by specific interest groups such as political constituents. This led regulators to set prices as close to variable costs of production as possible, preventing the company from making investments in infrastructure, hurting the quality of and access to services, or possibly, increasing the fiscal burden on the government[42] (Armstrong and Sappington, 2006). Indeed, this emerged as a particularly acute problem in many developing countries. The lack of strong legal or other independent institutions to enforce long-term contracts between the regulator and the company and prevent the regulator from reneging on previously announced terms in response to pressure from other government agencies or the citizenry at large, exacerbates this problem (Armstrong and Sappington, 2006).

Although the triggers for electricity reform in various parts of the world have been different – for instance, mainly ideological in the UK, and mainly due to macroeconomic crises in parts of Asia and Latin America – technological advances played a large role in the pursuit of reform towards competitive market structures by reducing the minimum efficient scale of operation, challenging the traditional vertically integrated monopoly, and enabling the functional decomposition of the industry (Steiner, 2000).

Against this changing context, it was argued that replacing regulation with competition could increase efficiency[43] (Newbery, 1996; Steiner, 2000), and liberalisation was seen as complementing or facilitating competition – namely, liberalisation is not an end in itself but a means to an end (competition).[44] Armstrong and Sappington (2006) argue for instance that the greatest gains from competition tend to arise when industry scale economies are limited relative to consumer demand; the industry regulator has limited information, limited resources and limited instruments with which to craft policy; the regulator's commitment powers are limited; and, subsidisation of consumption of some of the dominant supplier's services is either not critical or can be achieved by means other than through distortions in the supplier's price structure.[45] The theoretical literature postulates that entry (or the removal of entry barriers) is crucial to welfare-enhancing competition (Armstrong and Sappington, 2006). This is supported by associated literature, such as the market structure-performance-conduct paradigm developed by Mason (1939) and Bain (1951), which hypothesises that higher profitability in any market is associated with anti-competitive behaviour induced by higher market concentration (Njegomir et al., 2010).

In practice, it is impossible to instantaneously transform a monopolistic state-owned industry into a competitive one, and there are several reasons for the complexity and speed of transitions.[46] Some of these are distributional, while some are technical (Helm and Jenkinson, 1997). When the core natural monopoly element is separated (or unbundled), contracts may be put in place between companies at different vertical positions in the production chain, which reproduce many of the characteristics of vertical integration (Helm and Jenkinson, 1997).[47] Although this could be welfare-enhancing under

[41] A profit maximising monopolist may in theory prefer to serve low-cost areas which typically exclude more expensive to serve, unconnected consumers in rural areas, for instance.
[42] If, for instance, the government compensated the company through the national budget.
[43] A wealth of literature exists on this, covering aspects such as the Averch-Johnson effect (Steiner, 2000).
[44] However, liberalisation redistributes rents and raises new regulatory problems (Newbery, 1996).
[45] For instance, financial support might be provided directly to consumers that would find price increases to be the most burdensome; such a policy can replace implicit subsidies to all consumers with explicit subsidies to those with the greatest need for financial assistance (Armstrong and Sappington, 2006).
[46] For instance, the transition in the UK took nearly a decade and one could argue that the industry has still not achieved 'competitiveness' to the furthest possible degree.
[47] Given long asset lives and sunk investments, it may be rational for companies to sign contracts with consumers to reduce the risk of investing. For instance, in the UK, it has been argued that the industry was more vertically integrated in the early years after privatisation than before, despite the vertical separation of formal ownership (Helm and Jenkinson, 1997).

some circumstances[48], it may create barriers to entry as well (Helm and Jenkinson, 1997). Armstrong and Sappington (2006) argue that as the industry proceeds towards greater competition, market power remains a concern, and may shift from being exercised through pricing to being exercised through capacity.

Against this context, contrary to the view of some of the early exponents of competition, there is little evidence that if competition arises, regulation will 'wither away' (Helm and Jenkinson, 1997). Armstrong and Sappington (2006) argue that regulation should be eventually replaced by antitrust authorities in the drive towards greater competition. Antitrust policy and regulatory policy differ in three aspects: first, antitrust policy typically sets guidelines that broadly describe acceptable behaviour and outcomes, while regulatory policy specifies detailed rules, often applying to particular firms. Second, antitrust policy entails *ex post* investigations of possible violations of guidelines, while regulation couples *ex ante* rules with industry oversight and rule enforcement. And third, antitrust policy relies on edicts to discontinue anticompetitive behaviour and associated fines, while regulation proscribes specific types of conduct with rewards and penalties. The theoretical literature also postulates that there are instruments that could engender greater competitiveness in the so-called 'transition' towards 'full' competition. For instance, a system of auctioning (or bidding) franchises may capture much of the surplus for consumers.

Privatisation is not seen as necessary to engendering competition, as major electricity reformers such as Norway[49] have undertaken competitive reform under public ownership (Newbery, 2006); however, relative to monopoly, private companies' focus on lowering costs can generate a higher surplus and thus potentially be welfare enhancing. But a key problem here is the fact that under vertically integrated public ownership in countries where regulatory capture and weak institutions are prevalent, prices are set below costs at the outset, often in an attempt to subsidise (or cross subsidise) poorer consumers through the pricing system, which then becomes entrenched. The removal of these subsidies is arguably equivalent to the imposition of a tax for these consumers. In this scenario, privatisation (and liberalisation, more generally) would require prices to rise *above* costs in the initial stages, leaving poorer consumers worse-off. A generalised explanation of this effect is provided by Kahn (1979) who argues that liberalisation can be welfare enhancing only when average costs are above marginal costs, as there is then scope for competition to drive down system average costs and potentially final prices; but when average costs lie below marginal costs at the outset, rising prices (or government intervention) are more likely. Specifically, competition undermines cross-subsidies. However, the theoretical literature postulates that liberalisation and privatisation could potentially still be welfare enhancing when combined with direct transfers or lump sum payments to consumers who are made worse off (Armstrong and Sappington, 2006).

The theoretical literature therefore postulates improved efficiency, the maximisation of economic surpluses and potential enhancements in consumer welfare as some of the important underlying rationale for reforms and restructuring, set against the context of the evolution and characteristics of the electricity industry. However, it also recognises that the most appropriate liberalisation policy can vary considerably according to the institutional setting in which it is being implemented (Armstrong and Sappington, 2006).

[48] For instance, when the upstream sector is not competitive (Helm and Jenkinson, 1997).
[49] Notably, with strong institutions.

3.2 Empirical Literature

Although there exists a large body of literature looking at the experience and impacts of electricity sector reform[50], within this there is a limited strand of literature that focuses on assessing the outcomes of electricity sector reform through cross-country econometric analyses. Much of the existing cross-country econometric literature has focused on developed (OECD) economies whereas developing economies are subject to country-specific factors, sometimes resulting in counterintuitive outcomes (Victor and Heller, 2007; 2004; Jamasb et al, 2005). Cross-country econometric assessment is complicated by challenging model specification issues (Kessides, 2012). According to Kessides (2012) most econometric studies have arrived at a common set of conclusions: efficiency gains from electricity sector reform are modest, and in the absence of competition, are contingent on the effectiveness of regulation; where there is competition, there is strong evidence that this leads to greater positive effects relative to privatisation or even regulation; in countries where prices were not cost-effective at the time of initial reform, liberalisation leads to higher prices - however, in some instances a portion of the efficiency gains are passed through, with prices falling for some categories of consumers; and finally, liberalisation has had a gradual positive effect on the removal of subsidy distortions.

The majority of cross-country econometric literature has focused on assessing the impact of reforms on sector performance (quality of service) and investments in installed capacity, as these are immediately pertinent to the reform process. Cubbin and Stern (2004; 2006) examine panel data for 28 developing countries using fixed effects Ordinary Least Squares (OLS) regressions over 21 years to conclude that the existence of a regulatory law and higher quality regulatory governance have positive impacts on per capita electricity generation and installed capacity. In a similar vein, ESMAP (2011) uses panel data for 20 developing countries to show that independent regulation increased electricity access substantially. Other studies within this category look at whether privatisation has been effective in combination with independent regulation and competition as opposed to a standalone measure (Zhang and Kirkpatrick, 2008; 2005). Nagayama (2010) using fixed effects regressions for 86 developed and developing countries finds that reforms (particularly IPPs, unbundling, the creation of an electricity regulator and wholesale markets) led to lower transmission and distribution losses; in contrast, Nepal and Jamasb (2012a) find that electricity sector reform measures on their own did not produce any significant impacts on transmission and distribution losses across 27 transition countries (using data from 1990-2010). Erdogdu (2014) using a panel dataset for 55 developed and developing countries over 35 years find with fixed and random effects models that reforms have led to higher levels of electricity self-sufficiency. However, the same author finds that progress in reforms also led to a decline in R&D investments in electricity – a somewhat contradictory result.[51] Some studies give weight to the supply side in reform outcomes. Weinmann and Bunn (2004) analyse how industry structure and resource endowment of a country affect the feasibility of reform. This concludes that given a set of structural characteristics 'substantial' policy reforms are only effective to an extent. There is also a sub-literature that focuses primarily on productivity and efficiency analyses of utilities using parametric and non-parametric techniques. Efficiency analyses present a mixed picture of success, as the distribution of any efficiency gains is contingent on the strength of the regulatory framework (Jamasb et al, 2005; Mota, 2003).[52]

A second area which has received a lot of focus in the econometric analysis of electricity sector reforms has been in relation to their impact on prices. In developed countries, reforms are ideally expected to lead to competitive (lower) consumer prices, whereas in developing countries, prices are expected to

[50] Jamasb et al (2015) conduct a comprehensive literature survey of over two decades of electricity reform experience in developing countries.
[51] Presumably, self-sufficiency in electricity would only be sustainable as a long-term strategy in the presence of innovation.
[52] We do not focus on this literature as it is unrelated to the scope of our research questions. See Jamasb et al (2015, 24-31) for a discussion of this literature.

rise initially as they move towards cost-reflective levels. Nagayama (2007) analyses the effects of reform on industrial and household electricity prices using a panel data set of 83 developing countries in three world regions[53] for 1985-2002. The study follows Steiner (2001) and Hattori and Tsutsui (2004), investigating the impact of reforms on a set of performance measures, where each measure is a function of (i) country-specific effects, (ii) a set of controls and, (iii) a set of regulatory reform indicators. Nagayama (2007) concludes that privatisation and competition will only work with independent regulation. In a related study, Nagayama (2009) uses ordered response, fixed and random effects models to analyse panel data for 78 developed, developing and transition countries over 1985-2003 and finds that higher electricity prices tend to drive liberalisation, but liberalisation does not necessarily reduce electricity prices. Sen and Jamasb (2012) use bias corrected fixed effects models on panel data for 19 Indian states to show that there is a rise in prices in the initial stages of reform, due to the prevalence of below-cost pricing, motivated by political economy factors, prior to reforms. Balza et al (2013) look at the relationship between private sector participation, institutional reform, and the performance of the electricity sector in 18 Latin American countries over four decades, focusing on dimensions of efficiency, quality and access to electricity services, and end user prices. The study measures performance using a set of variables – real residential electricity prices net of taxes, percentage of households with electricity access, electricity capacity generation, and electricity loss as a percentage of total electricity production. In terms of explanatory variables, it uses the cumulative investment in the electricity sector as a percentage of average gross capital formation, an additive index of four regulatory dimensions (electricity law, independent regulation, license fee regulatory funding, and free pay scale for staff), and as control variables, GDP (PPP) and a 'polity' index capturing the degree of relative autocracy or democracy. Using Generalised Least Squares (GLS) estimations, the authors conclude that privatisation is robustly associated with improvements in quality and efficiency, but not with accessibility to the service. In contrast, regulatory quality is strongly associated with better performance in terms of both quality and accessibility. Erdogdu (2012) uses fixed and random effects models on 63 developed and developing countries over 27 years and finds no conclusive impact of reforms on price-cost margins or cross subsidy levels. In contrast, the ESMAP (2011) study applies panel data techniques on 20 countries with different system sizes to conclude that vertical unbundling reduced electricity prices by 10 per cent.

A related but limited strand of the econometric literature examines the influence of different contextual or institutional factors on the outcome of electricity reforms. Nepal and Jamasb (2012a) widen the scope of econometrically assessing electricity reform by relating its effectiveness to wider institutional and socioeconomic reforms using indices of economic governance, financial reforms, overall market liberalisation (competition policy, trade, the foreign exchange system) and other infrastructure reform (roads, water and telecoms) on a panel dataset comprising 27 transition economies of the Former Soviet Union. Their study measures the impact of reform indices on a set of outcomes categorised into economic (per capita GDP, installed capacity and renewables capacity), technical (per capita electricity production, electricity from renewables and transmission and distribution losses) and environmental (carbon emissions intensity and energy intensity). The results support arguments on the importance of implementing power sector reforms within a broad institutional framework. In a different vein, Erdogdu (2013) investigates the impact of political economy variables on the electricity liberalisation process for 55 developed and developing economies using bias corrected estimation techniques on panel data. The study finds that countries with larger industry sectors tend to liberalise less, and that it cannot be conclusively argued that liberalisation policies are stronger in more democratic countries. The study also finds that countries that receive foreign financial aid or assistance are more likely to liberalise their electricity markets – although this is a somewhat obvious result given the main driver of reforms amongst developing countries (structural adjustment programmes). The study also suggests that EU or

[53] This does not include Asian developing countries.

OECD membership, population density, electricity consumption, income level, educational level, imports of goods and services (as a percentage of GDP) and country-specific features have a strong correlation with liberalization in electricity markets.

3.3 The Gap in Literature

The gap in literature is evident as one steps away from literature investigating the impacts of electricity sector reform on sector performance *per se* and towards its links with and impact on wider welfare indicators. One approach has been to assume a positive cumulative impact from the implementation and outcomes of electricity sector reform on macroeconomic indicators. However, the evidence has been mixed. 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. On the other hand, Nepal and Jamasb (2012a) in their analysis of the impact of reforms in 27 transition countries show that power sector reform on its own did not produce significant effects on macroeconomic variables, but in combination with other institutional reforms, the results may be positive and significant. Vu and Gurtoo (2014) attempt to econometrically extrapolate the links between utility sector reform and socioeconomic development and poverty reduction for five South Asian economies using a dataset spanning the period 1990-2008. The questions asked in their study closely relate to the objectives of this paper – after more than two decades of utility sector reform, is the sector contributing significantly to the economic growth of these countries? The paper outlines the already proven link between basic infrastructure services (including electricity) to combat poverty (Bhattacharya, 2007). It investigates these questions by examining the contributions of the South Asian utility sector (for the sample) to GDP and employment (growth and average labour productivity). The paper uses growth decomposition frameworks applied to the Asian Productivity Organisation dataset. While this paper establishes a relationship between utilities sector reform and socioeconomic outcomes by looking at macroeconomic indicators, its scope is limited by sample size.

The gap in econometric literature is further evident when we look at studies on electricity reforms which attempt to link reforms with improvements or deterioration in consumer welfare. Jamasb et al (2015) show that the literature consists exclusively of qualitative case studies combined with social cost-benefit analysis, often conducted at the utility level (due to the nature of social cost-benefit analysis).[54] These studies are also constrained by the availability of reliable accounting data at the utility level, and convincing cross-country comparisons are almost impossible using this technique. Econometric studies of the impact of reforms on poverty reduction, on the other hand, have tended to focus on the micro level and rely on single-country cross-sectional household survey data. Khandker et al (2012a; 2012b) use maximum likelihood probit models looking at the impact of electrification on household income.

This review of literature suggests that existing literature often fails to go beyond sector performance, such as the fact that reforms have failed to bring about cost reflective pricing, to the issues which underpin these performance outcomes – for instance, the welfare issues which may have prevented cost-reflective performance. There is thus a case for extending the investigation on impacts of electricity reforms to welfare issues. It is clear that a gap exists in the literature on a systematic empirical analysis of the impact of the textbook model of electricity sector reform on technical, economic, and welfare indicators. The non-OECD Asian economies – which have not been collectively analysed in the literature – present a pertinent sample. They comprise one of the world's largest regional populations

[54] Galal et al (1994) has been the forerunner of literature using social cost benefit analysis to examine the impact of electricity sector reform.

living below the poverty line, as well as one of the largest potential future regional energy consumers and hence drivers of global energy use, as described in the introductory section.

This paper attempts to bridge the gap in literature in the following ways. First, it contributes to the literature on electricity reform in Asia using a large assembled dataset on non-OECD developing Asian economies, covering 17 countries and 23 years. Second, it draws the link between electricity reform on sector (technical) performance, on economic impacts, and on welfare indicators, assuming a cumulative impact of reform. Third, it utilises econometric techniques which allow for cross-country comparisons whilst controlling for differing institutional and political contexts. And finally, this is the first paper which aims to examine the impact of electricity reform on non-OECD Asian countries as a whole.

3.4 Hypotheses

As discussed in section 3.1, the underlying rationale for electricity reform has its foundations in microeconomic theory, and postulates that measures of restructuring aimed at engendering competition will maximise total economic welfare, particularly consumer surplus. In developing our set of hypotheses, we draw upon this rationale. We also draw from the wide range of existing but disparate literature (as well as the gap in literature) to assemble a set of potential indicators which reflect the impacts of electricity sector 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 measures of electricity sector reforms (with relevant controls) on these representative impact variables, whilst controlling for factors such as institutional and political differences, and differences in resource endowments, using a panel dataset spanning 17 non-OECD Asian economies[55] across 23 years (1990-2013). The choice of variables is informed to some extent by data availability, and hence we are careful to draw associations rather than claim direct causality.[56] Our econometric method – which is discussed in the next section, accounts for the influence of unobserved heterogeneity (or 'other' factors) in as much as is possible in an empirical study of this kind. The empirical method can be expressed in terms of three separate hypotheses. Our conceptual approach is that each hypothesis builds on the preceding hypothesis, and in this we also draw heavily from existing literature.

The most immediate impact of electricity sector reform should be on sector performance *per se* in relation to the objectives of the textbook model of reform, broadly speaking - technical improvements. This can be indicative of broader improvements – for instance, high transmission and distribution losses can be a result of inadequate investments in network maintenance and upgrade, which can in turn be tied to capital constraints resulting from below-cost pricing. Following from this, 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, and can be expressed as follows:

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

[55] Nepal, Bhutan, Maldives, Myanmar, China, Malaysia, Indonesia, Philippines, Thailand, Laos, Brunei, India, Pakistan, Bangladesh, Sri Lanka, Singapore, Vietnam.
[56] The description and units of measurement of variables are in Table 3.

We use per capita transmission and distribution losses as the dependent variable – this has also been the most widely used variable in the literature.[57] Our main explanatory variable is an additive electricity reform index, drawing from Balza et al (2013), Nepal and Jamasb (2012a), Sen and Jamasb (2012), Nagayama (2007), Cubbin and Stern (2005), and Hattori and Tsutsui (2004). The index comprises six measures: (a) the existence of Independent Power Producers (IPPs) in generation (b) the existence of an electricity regulator as a separate, distinctive body[58] (c) unbundling of the state utility (d) corporatisation of the utility (e) open access/ third party access to network infrastructure (f) distribution privatisation. We construct our index based on the realities of electricity sector 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 under investigation do not have truly independent regulators, but we nevertheless wish to study the effect of regulation and therefore include it in the reform index. Dummies (0/1) are assigned to each individual reform measure and we aim to regress both the individual scores and the additive index on the dependent variable in our initial runs.

We are also interested in capturing interaction effects between various reform measures, following the methods adopted by other studies in the empirical literature (Zhang and Kirkpatrick, 2002; Cubbin and Stern, 2006; 2004). We therefore include three interaction terms among our regressors: the first is [regulation*distribution privatisation], based on the assumption that privatisation cannot work without effective regulatory structures; the second interaction term is [IPPs*open or third party access], based on the assumption that open access to transmission and distribution networks enables consumers to harness the full potential of electricity generated by IPPs[59]; and the third interaction term is [unbundling*corporatisation] – where 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 the institutional capacities of the different countries in our dataset 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. The CPI is the most widely used indicator of transparency worldwide.[60] The underlying assumption is that stronger institutions and governance will enable better transparency of operations, less rent-seeking and more effective outcomes. We include per capita power consumption as a control variable – as higher power consumption in absolute terms would lead to higher transmission and distribution losses.

[57] 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 of the studies reviewed in the literature utilise per capita measures, particularly for developing countries, due to issues related to data availability and standardisation. We therefore use per capita measures, but also provide details of electrification rates in Appendix II (electrification is further discussed in Section 5).

[58] Whether independent or not.

[59] 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.

[60] The Transparency Index, published annually by Transparency International, 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. It compiled from the following 12 reputed 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. The detailed methodology and dataset are available to freely download from http://www.transparency.org/cpi2014/in_detail.

Our second hypothesis broadens the scope of electricity reform impacts to beyond sector performance *per se* and draws from the literature (Vu and Gurtoo, 2014; Erdogdu, 2013; Nepal and Jamasb, 2012a; Sen and Jamasb, 2012) to postulate the **economic impact** of electricity sector reform.

- *H2. Electricity sector reforms in developing, non-OECD Asian economies have led to positive impacts on economic growth.*

We use per capita GDP as our main dependent variable – this is consistent with previous literature (Sen and Jamasb, 2012); our 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. We also account for differences in initial resource endowments using per capita total installed capacity.[61] A secondary indicator of economic growth performance is the openness of economies to international trade (or in this case, inter-regional trade that is mostly bilateral).[62] We therefore estimate a second equation for this hypothesis using per capita electricity trade (defined as electricity exports + electricity imports as a percentage of total electricity generation)[63] 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 the impact of electricity reforms on consumer welfare – which, as discussed in our review of literature, has been largely 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 for our third hypothesis, and hence two dependent variables. The first dependent variable that we use is the Gini coefficient, which captures the welfare aspect through its representation of income distribution. And second, we use the Human Development Index, which covers social wellbeing in a wider sense through its representation of standard of living, educational attainment and life expectancy in a society.[64] Our 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 control variables, we include the transparency index to represent institutional differences, using the previous reasoning that stronger institutions will

[61] 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.

[62] Frankel and Romer (1999) is one of the forerunners of studies looking at trade and economic growth by geographic region, for instance.

[63] This is consistent with the World Bank World Development Indicators' definition of trade.

[64] These are measured through per capita income, mean years of schooling and expected years of schooling, and life expectancy at birth.

enable better transparency of operations, less rent-seeking and more effective outcomes. We also include per capita electric power consumption as a control variable.[65]

The characteristics of the variables included in our hypotheses implies 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 (described in the econometric method), 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.[66] In this way, we are able to also estimate reform impacts under different country-specific political frameworks. The results from the three estimations, taken in entirety, can help us draw valuable observations on the progress and consequences of electricity sector reform in the developing economies of non-OECD Asia.

In addition to the three hypotheses above, we are also interested in investigating the effects of reform on investment in generation – which is 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 of the countries in our sample have suffered from chronic electricity deficits, and reforms were carried out in the absence of excess capacity in these countries. The impact of reforms on the stock of installed capacity is therefore relevant.[67] And second, a large number of countries in our dataset have considerable amounts of hydroelectric resources, yet these have not been fully developed due to financial and political constraints. [68] We therefore include results from two additional estimations to explore these effects.[69]

4. Empirical Method

Our dataset comprises of 17 cross-sections, covering 23 years and constituting an unbalanced panel. Each cross section represents a non-OECD Asian economy, with a range of country-specific unobserved factors influencing the behaviour of each. We therefore begin developing our econometric method by looking at techniques from panel data econometrics which are best placed to deal with heterogeneity in the micro-units[70].

Within panel data, the choice broadly lies between fixed effects (FE) and random effects (RE) estimators, which differ in the way they model the unobserved heterogeneity. The FE estimator deals with it explicitly in the estimation process by putting in a dummy for each individual – it is therefore also referred to as the Least Squares Dummy Variable (LSDV) estimator. The RE estimator implicitly recognises it, and assumes the different intercepts as having been drawn from a bowl of possible

[65] 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.
[66] The data was obtained from the 'Freedom in the World Report' published by Freedom House and freely available at https://freedomhouse.org/reports
[67] This was in contrast with OECD countries, where electricity reforms were carried out in the presence of excess capacity. See Sen (2014) for a comparative analysis.
[68] See BP Statistical Review of World Energy (2015) for data on hydroelectric production.
[69] Although decarbonisation is an important element of developing country energy goals, it is beyond the scope of this paper as electricity sector reform programmes had never been originally intended to address it as a separate goal. Most developing countries, unlike OECD countries, have addressed decarbonisation and the addition of renewables capacity outside of electricity reform programmes.
[70] In this section we draw on Sen and Jamasb (2012) in developing our econometric method. Kennedy (2008) provides a detailed exposition of panel data techniques and the choice of fixed versus random effects estimators in applied econometric research.

intercepts, so they may be interpreted as random, and treated as though they were a part of the error term. The FE estimator is always consistent[71], but the RE estimator, where applicable[72], is more efficient[73], as the method of transformation used in the estimation process saves on degrees of freedom.

In order to conform to desirable properties of an estimator (unbiasedness), RE estimators are applicable solely under the assumption that the individual effects (and hence the composite error term) are uncorrelated with the explanatory variables. Standard procedure dictates that this choice is usually determined through the use of a Hausman Test. However, given that our cross-sections represent different countries, which are self-contained socioeconomic systems, these inherent differences represent unobserved heterogeneity. It is highly likely that the unobserved heterogeneity, and hence the individual effects, would be correlated with the independent variables, i.e. factors such as governance and institutions could influence explanatory variables. Thus, the core assumption for a RE model could be violated in this case. FE estimators are thus preferable. A second justification for FE estimators is that the data does not represent a random sample; further, as the total number of states (cross-sections) is limited, the data comprises a finite sample.

The basic specification for a fixed effects model is: $Y_{it} = \alpha_i + \beta X_{it} + \eta_i + \varepsilon_{it}$. However, we further note that our dataset has a finite and relatively small time dimension, '*T*' and it is established in econometric literature that a LSDV model biases estimates when *T* is small; thus, LSDV performs well only when *T* is large (Judson and Owen, 1999). Kiviet (1995) devised a bias-corrected LSDV estimator (LSDVC), later refined by Bun and Kiviet (2003), which is generally seen to have the lowest RMSE[74] 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'. In the procedure for obtaining results from a LSDVC estimator from an unbalanced panel, uncorrected LSDV estimates are first obtained. Then, using Kiviet's higher order asymptotic expansion techniques, the small sample bias of the estimator is approximated (Bruno, 2005). The approximations terms, however, all evaluated at the unobserved true parameter values, are of no direct use for estimation; thus to make them operational, the true parameter values are replaced by estimates from some consistent estimator (Bruno, 2005). The chosen estimator is plugged into the bias approximations formulae, and the resulting bias approximation estimates $\overline{\beta_i}$ can be subtracted to obtain the corrected LSDV estimator as follows: $LSDVC_i = LSDV - \overline{\beta_i}$ **,** where *i* = 1,2 and 3, indicating the accuracy of the bias approximation. The choice of consistent estimators used to initialise the bias approximations lies between the Anderson-Hsiao, Arellano-Bond and Blundell-Bond estimators.

Given the characteristics of our dataset, the bias corrected LSDV estimator initially appears to suit our purpose. 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)[75] and Generalised Method of Moments (GMM)[76] estimators have therefore been proposed in econometric literature as alternatives to the bias corrected LSDV estimator. We opt for an instrumented

[71] The estimator converges in probability to the true value of the parameter.
[72] The variables being used and the relationships being hypothesised must satisfy certain assumptions.
[73] Minimises variance amongst unbiased estimators.
[74] Root Mean Square Error.
[75] For a discussion of instrumental variables see Baum (2006) and Wooldridge (2010; 2013)
[76] See Hall (2005) for an explanation of GMM regression.

variable regression using the STATA routine *ivregress*.[77] This fits a linear regression of *depvar* on *varlist₁* and *varlist₂*, using *varlistᵢᵥ* (along with *varlist₁*) as instruments for *varlist₂*.[78] It supports estimation using two-stage least squares (2SLS) and GMM estimators.

The model estimated under this routine is as follows:

$$y_i = Y_i\beta_1 + x_{1i}\beta_2 + u_i \qquad \textit{(Structural equation)}$$
$$Y_i = x_{1i}\Pi_1 + x_{2i}\Pi_2 + v_i \qquad \textit{(First-stage equation)}$$

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 the implementation of individual reform measures, in our estimations we drop the total reforms index. We then instrument for distribution privatisation using an index of political reform[79] 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, Lobina and Motte, 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.[80] Instead, we carry out two post-estimation tests to validate the robustness of our results. The first is a test of endogeneity, 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.

[77] 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.
[78] *varlist₁* and *varlistᵢᵥ* are the exogenous variables, and *varlist₂* the endogenous variables.
[79] The Freedom House index, as discussed in earlier sections.
[80] See Stata manual http://www.stata.com/support/faqs/statistics/two-stage-least-squares/

4.1 Data

As discussed earlier, data was gathered to assess the progress of electricity sector reform against the 'typical' set of measures in Table 1, along with data on dependent and explanatory variables, to construct a dataset of 17 non-OECD Asian countries during the period 1990-2013 (23 years). Our data constitute an unbalanced panel. Tables 2 and 3 detail the variables used.

Table 2: Estimating the Technical, Economic and Welfare Impacts of Electricity Sector Reform in 17 non-OECD Asian Developing 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; Interaction Terms	Per capita total installed capacity, transparency index
	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

Var. Label	Var. Name	Units
Dep. 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

A distinctive characteristic of our data is that we utilise variables from large well-publicised datasets, such as the World Bank's World Development Indicators, International Monetary Fund database, Freedom House Index, and Transparency International Index, which reduces problems with standardisation. In constructing our reform measures/index, we utilise a comprehensive survey of country-specific sources for country experience. The variables were scaled to represent per capita data and were further standardised by carrying out log transformations.[81]

[81] 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.

5. Results and Discussion

Electricity reforms were implemented in non-OECD countries based roughly on the 'textbook' OECD model based on the underlying reasoning that they would lead to improvements through efficiency, the maximisation of total surplus, and transfer of surplus to consumers. The literature has shown very mixed results, and although there has been much theoretical debate and some limited empirical findings on the role of differing institutional contexts in the non-OECD, there has been no clear overall evidence-based assessment of the effectiveness of the textbook model for non-OECD developing countries of Asia as a whole. In this section, we present the results of our econometric analysis.

Given the characteristics of the electricity sectors of the Asian countries and the conditions under which the reforms were carried out, our results at times appear counterintuitive to conventionally expected outcomes under the textbook model. In this section, we also seek to explain the reasons behind these results. The results from the analysis are presented in Tables 4 and 5.[82] Our results are largely consistent across the GMM and 2SLS estimations conducted for each (sub) 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. As mentioned, our results for non-OECD Asian developing countries are not always unambiguous. Two variables – per capita 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.

The only effective measure of electricity reform is corporatisation, which has a significant negative association with transmission and distribution energy losses. In 12 of the countries in our sample, corporatisation has succeeded or occurred alongside unbundling of state-owned utilities. In this regard, our results differ from the existing literature as they postulate 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.[83] Although unbundling constitutes, as a minimum, the 'accounting separation' of utilities' finances, the incorporation under company law of utilities through corporatisation facilitates a closer remit and accountability over commercial and technical losses. Corporatisation should therefore precede measures such as distribution privatisation and liberalisation of retail supply, and this has been a major lesson drawn from past reform experience.

For example, in India, the first instance of distribution privatisation was carried out in 1996/97 in the state of Orissa without prior restructuring or corporatisation, as public assets were directly sold to private operators. However, an audit during the restructuring process following privatisation revealed that the transmission and distribution losses had been seriously understated prior to the sale[84] – this affected the financial plans of the private operators and has since been identified as one of the contributing factors in the failure of privatisation in Orissa. Consequently, the Delhi privatisations in 2003 were carried out *after* unbundling and corporatisation, and the sale of public companies focused on levels of commercial and technical losses, with the bid being awarded to the private operator that promised the

[82] Postestimation tests are reported in Appendix I, and descriptive statistics in Appendix III.
[83] 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.
[84] They were reported at 24 per cent prior to the privatisation, but following an audit after privatisation they were actually found to range around the level of 43 per cent (Rajan, 2000).

biggest reductions in these losses over the following five-year period.[85] Our results therefore show, albeit not overwhelmingly, that corporatisation has been associated with a significant reduction in the network energy losses in these economies. 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)[86], 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).

5.2 Economic Impact

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

5.2.1 Per Capita GDP

As seen in Section 3, the evidence from the literature has generally shown a positive impact of electricity reforms on economic growth, although the econometric studies which have postulated this have focused on large cross-country datasets without a specific regional, geographic or contextual focus (Nepal and Jamasb's (2012a; b) work on transition economies being the exception), or alternatively, country-specific studies (Sen and Jamasb, 2012). As seen in Table 4, the results for GDP partially support this view 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.

While distribution privatisation on its own appears to have had a positive significant association with GDP, in combination with regulation (as demonstrated through the interaction variable [regulator*distribution privatisation]) we observe that it has a negative significant association with GDP. This result runs contrary to the literature – for instance, Zhang and Kirkpatrick (2008) found no evidence that privatisation has been effective in combination with independent regulation and competition as opposed to a standalone measure.

Conversely, the literature supports the view that the quality of regulation determines electricity market outcomes. Cubbin and Stern (2006), for instance, find that higher quality regulatory governance leads to positive outcomes. Our results may therefore arguably be reflective of weaker regulatory frameworks amongst the majority of countries in our dataset. Indeed, as discussed in Section 2, most of the regulators in our dataset are not independent; they represent quasi-government agencies or extensions of government. It is plausible to argue that a lack of independent regulation could have constrained the effectiveness of distribution privatisation.

Our results run counter to theoretical literature, and to results from studies carried out in different country and institutional settings; but this is unsurprising as the political economy of reforms in developing countries have, as discussed in the literature review, tended to influence reform outcomes (Rufin, 2003; Victor and Heller, 2007).

Another result relates to the impact of open access regulations, which on its own has a negative significant association with GDP, but in combination with the presence of IPPs, shows a positive

[85] As a result, technical and commercial losses were brought down to 17 per cent from levels of almost 65 per cent.
[86] 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.

significant association with GDP. However, when placed in the context of the largely resource-deficit developing countries such as ours, 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 the provision and consumption of electricity. Functional IPPs enable the utilisation of open access – particularly to industrial consumers. The control variables show strong positive significant associations with GDP – namely, a higher amount of installed capacity, and a larger transparency index, indicating a greater degree of functioning institutions – are both on the whole associated with higher per capita GDP.

5.2.2 Per capita electricity trade

Our second estimation examined the impact of reforms on economic growth via their effect on electricity trade – this was included against the context of long standing efforts to promote regional electricity cooperation in non-OECD Asia, particularly amongst the hydro-abundant and electricity-deficit countries of South Asia. The results, however, do not find a positive association with electricity trade from either the individual reform measures or the interaction variables. This is not unsurprising, but it also shows that reforms have not promoted regional electricity cooperation. Although well-functioning markets can aid regional electricity 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). However, in other world regions, such as in Latin America, bilateral efforts have graduated into or merged with market-oriented reforms, with firms eventually replacing political actors in the drive towards greater market integration (Raineri et al, 2013). Latin America provides a fitting comparison as it resembles the hydro-rich regions of South Asia. In fact, regional market integration in Latin America was undertaken because it would enable the removal over time of large price disparities that had existed amongst the countries (Raineri et al, 2013). Our results show that the same effect has failed to occur in developing non-OECD Asia, despite the existence of several cross-border bilateral electricity initiatives.[87] One constraint has been the rise of resource nationalism over hydro reserves in hydro-rich South Asian countries.[88] The lack of a solution to these largely political constraints has prevented the graduation of cross-border initiatives to wider, regional initiatives that can be linked in with national-level electricity reforms.

Notably, two of the control variables used in this estimation – per capital installed capacity *less* hydroelectric installed capacity (l.poic)[89], and the transparency index (l.trpi), are highly significant. 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 above 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. At the same time, imports have tended to be of fuel rather than electricity, particularly as the infrastructure for cross-border electricity trade is limited (the results from additional estimation on the total stock of electricity infrastructure are presented later in this section). Finally, 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.

[87] Singh et al (2015) contains an account of these initiatives.
[88] Strahorn (2011) discusses these largely political constraints. It is interesting to note that resource nationalism is a constraint when hydro resources are opened up to foreign governments rather than private sector firms.
[89] As argued in Section 4, we chose to include hydro installed capacity as a separate variable in order to filter the influence of hydro resource endowments, which are predominant amongst the South Asian countries in our dataset.

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 Gini Coefficient

Our first estimation measures the impact of electricity reforms on key socioeconomic indicators using 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 for the poor (Estache et al, 2000; Calderon and Severn, 2004). A more direct effect of electricity reforms on income inequality is through their impact on electricity prices for low-income households (Jamasb et al, 2015).[90] The Gini coefficient can therefore be seen as capturing both effects.

Our results find that different reform measures have had different directions and impacts on the Gini coefficient – as seen in Table 5. The presence of a sector regulator has a significant (at 10 per cent) negative association with the Gini coefficient implying that on the whole, regulation has occurred alongside reduced income inequality in the countries in our sample.[91] This observation is broadly supported by cross country studies on the impact of electricity reforms on access using global datasets which find econometric evidence of the impact of regulatory laws and government on increasing per capita electricity generation and installed capacity (Cubbin and Stern, 2004; 2006; ESMAP, 2011; Zhang et al, 2005; 2008). Thus, this finding is in line with the arguments on access to infrastructure.

On the other hand, distribution privatisation is associated with an increase in income inequality.[92] 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.[93] This is supported by empirical literature (Nagayama, 2007; 2009; Sen and Jamasb, 2012). This 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 the control variables, we find that per capita electricity consumption has been associated with a higher Gini coefficient, thus implying higher income inequality. While at first glance this is counterintuitive, it can be related back to increased access to electricity – if higher per capita electricity consumption is not a consequence of increased rates of electrification, then it could be an indicator of income inequality, as it implies that the higher income groups of the population consume more electricity. In order to explore this further, we look at the change in national electrification rates in the

[90] We were unable to obtain reliable time series data on electricity prices for the countries in our dataset.
[91] 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.
[92] Significant at 10 per cent.
[93] This is in contrast with the OECD experience, where reforms were implemented in a situation of excess capacity.

countries in our dataset over a decade. The figures in Appendix II (Figures A&B) accordingly depict the percentage of population with access to electricity (total and rural) for the years 2000 and 2012.

There do not appear to be large increases from 2000 to 2012[94] in the percentage of total population with electricity access in Figure A, apart from Bangladesh, India and Laos, which experienced increases of 20-30 per cent. Figure B shows a similar pattern for percentage of rural population with electricity access, with the exception of two countries (Bangladesh and Nepal) where gains of 50 per cent or more were achieved in a decade.[95] The literature appears to support this conclusion. For instance, Khandker et al (2012b) in an econometric analysis 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. Joseph (2010) shows how IPPs and open access resulted in the segregation of industrial consumers from residential and agricultural consumers, allowing industrial consumers to opt out of electricity provision by the state utilities, leading to an increase in their electricity consumption.

Finally, we find that 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.[96]

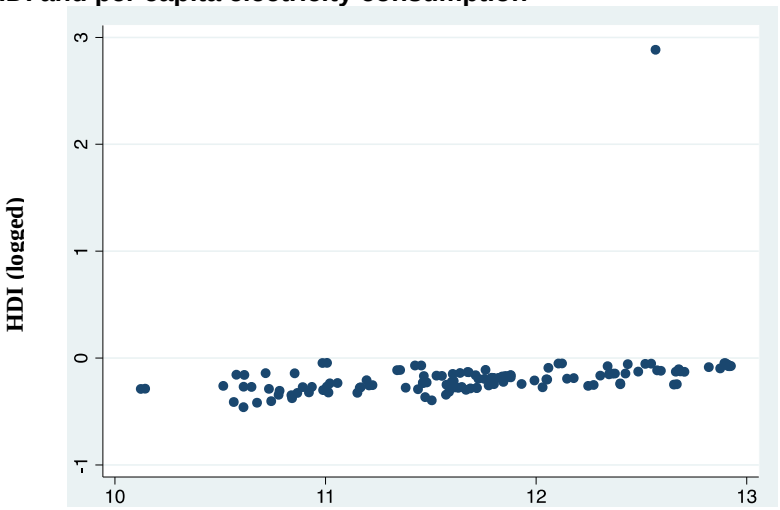
5.3.2 Human Development Index

The second estimation in our hypothesis on the socioeconomic impacts of electricity reform uses the HDI – a composite indicator of per capita income, literacy and life expectancy as described in Section 4, as the dependent variable. As demonstrated in the literature review, there have been no previous attempts to econometrically investigate this impact for any dataset. 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 finds only a weak relationship between the HDI and per capital electric power consumption.

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 electricity 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 electricity reforms as implemented through the textbook model 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 to show that independent regulation increased electricity 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 explicit extensions of government bureaucracy, or else quasi-government organisations open to government interference.

[94] This is the latest year for which data were available for all the countries in our dataset.
[95] A more accurate analysis would need to control for growth in population.
[96] This result may possibly have a temporal dimension, which is beyond the scope of this paper.

Figure 2: HDI and per capita electricity consumption



Source: Authors[97]

5.4 Additional Estimations

As discussed earlier, two additional estimations were carried out, the results of which are given in Table 5. The first estimation investigates the impact of electricity reforms on investment in generation capacity, using the total stock of installed capacity as a dependent variable. One purpose of electricity reform has been to attract private investment – our results show no association between reforms and 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.[98]

The second estimation investigates the association between reforms and per capita hydro installed capacity specifically, given the hydro resource endowments in many of the countries in our dataset and the potential for regional electricity trade. Our results 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 their fuel mix, have aimed at expanding private sector hydro IPPs.[99] However, the presence of a regulator, on its own, as well as in combination with distribution privatisation, show 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) that have expressed interest in developing

[97] The outlier is Singapore, which, as stated earlier is classified as a non-OECD country in Asia.
[98] This result has wider implications for private investment – a stronger institutional environment presumably engenders a favourable investment environment, which is applicable to sectors other than electricity.
[99] 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

these resources. 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 4: Results - I

	TECHNICAL IMPACT			ECONOMIC IMPACT (1)			ECONOMIC IMPACT (2)	
	Depvar: l.ptdl			Depvar: l.pgdp			Depvar: l.trade	
	GMM	*2SLS*		*GMM*	*2SLS*		*GMM*	*2SLS*
IPPs	0.089	0.063	**IPPs**	0.842	0.78	**IPPs**	-0.609	-0.902
	(0.20)	(0.29)		(0.64)	(0.64)		(0.88)	(1.212)
Regulator	0.033	0.039	**Regulator**	0.015	-0.012	**Regulator**	0.046	0.015
	(0.04)	(0.044)		(0.056)	(0.09)		(0.12)	(0.145)
Unbundling	-0.032	0.002	**Unbundling**	-0.173	-0.213*	**Unbundling**	0.011	0.005
	(0.06)	(0.063)		(0.26)	(0.13)		(0.173)	(0.19)
Corporatisation	-0.145***	-0.145*	**Corporatisation**	0.429***	0.399***	**Corporatisation**	-0.047	-0.215
	(0.06)	(0.08)		(0.14)	(0.16)		(0.20)	(0.29)
Open/Third Party Access	-0.012	0.015	**Open/Third Party Access**	0.999	-0.98*	**Open/Third Party Access**	0.55	0.80
	(0.19)	(0.27)		(0.86)	(0.59)		(0.798)	(1.09)
Distribution privatisation	0.149	0.614	**Distribution privatisation**	2.78**	2.68**	**Distribution privatisation**	-0.914	-1.57
	(0.44)	(0.62)		(1.30)	(1.36)		(1..88)	(2.60)
Per capita electric power consumption	0.632***	0.65***	**Per capita total installed capacity**	0.174***	0.196**	**Per capita total installed capacity (minus hydro capacity)**	-0.75***	-0.72***
	(0.06)	(0.06)		(0.068)	(0.101)		(0.099)	(0.154)
Transparency Index	0.04	0.036	**Transparency Index**	1.074***	1.02***	**Per capita hydro capacity**	0.055	0.081
	(0.14)	(0.15)		(0.210)	(0.282)		(0.052)	(0.066)

(Regulator*Distribution privatisation)	0.0007 (0.43)	0.09 (0.60)	**(Regulator*Distribution privatisation)**	-2.74** (1.25)	-2.60** (1.31)	**Transparency Index**	1.834*** (0.29)	1.743*** (0.314)
(IPPs*Open/Third Party Access)	0.026 (0.18)	-0.007 (0.27)	**(IPPs*Open/Third Party Access)**	1.056 (0.842)	1.12** (0.574)	**(Regulator*Distribution privatisation)**	0.488 (1.84)	1.147 (2.55)
(Unbundling*Corporatisation)	0.033 (0.07)	0.002 (0.062)	**(Unbundling*Corporatisation)**	-0.147 (0.31)	-0.089 (0.127)	**(IPPS*Open/Third Party Access)**	-0.154 (0.78)	-0.38 (1.093)
_cons	3.47 (0.62)	3.29 (0.44)	**_cons**	1.24 (0.54)	1.24 (0.54)	**(Unbundling*Corporatisation)**	0.028 (0.185)	0.045 (0.180)
						_cons	3.35 (0.58)	3.60 (0.63)
R^2	0.82	0.82	**R^2**	0.18	0.23	**R^2**	0.41	0.36
N	235	235	**N**	235	235	**N**	235	235

* significant at 10% ** significant at 5% *** significant at 1%; Standard errors in parentheses.

Table 5: Results - II

	WELFARE IMPACTS					ADDITIONAL ESTIMATIONS			
	Depvar: l.hdi		Depvar: l.gini			Depvar: l.pre		Depvar: l.phic	
	GMM	***2SLS***	***GMM***	***2SLS***		***GMM***	***2SLS***	***GMM***	***2SLS***
IPPs	1.208	1.219	0.12	0.095	**IPPs**	-1.53	-1.51	7.40**	7.28*
	(1.41)	(0.948)	(0.25)	(0.087)		(1.17)	(1.22)	(3.26)	(3.97)
Regulator	-0.245	-0.248	-0.081*	-0.045*	**Regulator**	0.15	0.079	-1.01**	-0.96**
	(0.315)	(0.25)	(0.05)	(0.024)		(0.099)	(0.151)	(0.45)	(0.49)
Unbundling	-0.123	-0.125	-0.12	-0.053	**Unbundling**	0.202	0.01	-0.35	-0.262
	(0.181)	(0.36)	(0.25)	(0.056)		(0.36)	(0.20)	(1.09)	(0.67)
Corporatisation	0.080	0.082	-0.06	-0.019	**Corporatisation**	-0.243	-0.28	0.24	0.23
	(0.16)	(0.224)	(0.08)	(0.027)		(0.212)	(0.29)	(0.81)	(0.93)
Open/Third Party Access	-0.70	-0.707	-0.09	-0.022	**Open/Third Party Access**	1.66	1.43	-5.99	-5.84
	(0.82)	(0.485)	(0.06)	(0.084)		(1.25)	(1.12)	(5.11)	(3.97)
Distribution privatisation	0.95	0.956	0.273*	0.143*	**Distribution privatisation**	-3.57	-3.30	13.04*	12.79
	(1.18)	(0.83)	(0.15)	(0.08)		(2.39)	(2.60)	(7.21)	(8.50)
Per capita electric power consumption	0.208	0.209	0.12***	0.037	**Transparency Index**	2.36***	2.30***	-0.68	-0.69
	(0.179)	(0.15)	(0.096)	(0.023)		(0.204)	(0.25)	(1.09)	(0.81)
Transparency Index	0.015	0.019	0.055**	0.30***	**(Regulator*Distribution privatisation)**	3.28	3.07	-13.43**	-13.27*
	(0.524)	(0.60)	(0.052)	(0.083)		(2.30)	(2.50)	(6.78)	(8.15)

(Regulator*Distribution privatisation)	-	-	-	-	**(IPPs*Open/Third Party Access)**	-1.45 (1.20)	-1.20 (1.07)	5.38 (5.00)	5.26 (3.48)
(IPPs*Open/Third Party Access)	-	-	-	-0.017 (0.073)	**(Unbundling*Corporatisation)**	-0.28 (0.39)	-0.08 (0.20)	0.88 (1.28)	0.79 (0.65)
(Unbundling*Corporatisation)	0.158 (0.234)	0.161 (0.344)	0.16 (0.28)	0.062 (0.058)	**_cons**	5.87 (1.23)	5.90 (1.35)	-2.52 (3.46)	-2.41 (4.40)
_cons	-3.72 (3.12)	-3.74 (2.05)	-	0.94 (0.27)					
R^2	-	-	-	-	**R^2**	-	-	-	-
N	75	75	59	59	**N**	235	235	235	235

* significant at 10% ** significant at 5% *** significant at 1%; Standard errors in parentheses.

6. Conclusions and Policy Implications

This paper has discussed how after more than two decades of attempts at electricity sector reform, there is a strong case for assessing the evidence on the outcomes of reforms, particularly for developing countries. We investigate the proposition from theoretical and empirical literature that reforms through the implementation of the 'standard' or 'textbook' model have been associated with improved technical performance, and positive economic and welfare impacts. To this end, we assembled and used a new and up-to-date panel dataset covering 17 non-OECD developing Asian economies observed over the period 1990-2013, comprising individual, interactive and collective measures of electricity reforms along with appropriate control variables, to which we applied instrumental variables regression (while controlling for the presence of endogeneity). Our results are subject to the limitations of data availability as with all econometric studies of this kind, and there is room for extending the findings using case study analyses.

We can draw three broad observations from our statistical results.[100]

- *First, measures of restructuring (or structural reform measures) carried out early on in the process of reforms appear to have had a greater influence in the outcomes of electricity reforms in non-OECD Asia. Specifically, corporatisation (both on its own and in combination with unbundling), which mandates not just the 'accounting separation' (at the minimum) of utilities, but also the incorporation under Company Law of utilities' finances and operations, appears to have produced positive technical and economic impacts. Corporatisation is also arguably the reform measure that most closely addresses the underlying problem of utilities' finances, which lie at the core of the success or failure of reforms in developing countries. Additionally, the quality of regulatory governance also appears to have been a factor in influencing reform outcomes. This is evidenced by the fact that even in countries which have undertaken both the structural and competitive reform elements of electricity provision, leading to wholesale markets, for instance, there continue to be problems with market power (often from formerly state-owned monopolies) as discussed in Section 3 of the paper.*

- *Second, our results also show a tension between economic and welfare impacts: namely, the reform measures that are associated with positive economic growth appear to be associated with negative effects welfare indicators. Specifically, while regulation constrains the impact of measures such as distribution privatisation on economic growth, it has a positive impact on socioeconomic/welfare indicators. Similarly, distribution privatisation is seen to have a positive association with economic growth, but a negative association with welfare indicators (such as the Gini coefficient), partially due to its tendency to lead to higher prices for consumers. For the HDI, electricity sector reforms are seen to have had no significant associations with welfare. This is an important result as the latter are particularly relevant for the non-OECD Asian developing countries in our dataset, which collectively represent 25 per cent of world population and a third of the world's poor population, but account for just 5 per cent of world electricity consumption.*

- *And third, our results also show that country-specific institutional factors have strongly influenced outcomes in non-OECD Asia, underscoring the point that the uniform application of the standard*

[100] Section 5 contained a more detailed analysis of results.

model without reference to the inherent heterogeneity that characterises the countries in our dataset is unlikely to have resulted in anticipated outcomes.

Our results therefore call for a renewed thinking, or a shift in focus – in other words, a 'reform' of electricity reforms. Specifically, the 'textbook' model of reform in its original form is incompatible with the contexts of non-OECD developing countries' electricity sectors, which possibly call for more localised reform programmes.

Further, the goals of electricity sector reform need to be carefully outlined by the governments which plan on undertaking them, so as to align them more closely with expectations on outcomes – this is particularly relevant as our results show that electricity reforms under the textbook model have had limited or no associations with welfare improvements (via access to electricity). In this sense, the restructuring of utilities' finances and operations and the extension of access ought to be more explicitly linked within electricity sector reform programmes, as a key problem with the textbook model in developing countries has been the inability of utilities to charge cost-reflective tariffs, resulting in underinvestment in extending electricity access, which in turn has failed to create positive impacts on welfare.

Our results have some important policy implications, opening wider questions for the role of government in electricity reforms.

- *First, it is evident that governments have tended to select 'pieces' of the standard model of full retail competition (or even wholesale competition), where competitive markets determine investment, prices and consumption. Certain structural measures – particularly unbundling and corporatisation – have appeared to be successful in improving technical measures and economic impacts. Others, such as regulation, have an ambiguous effect. For instance, where regulation may have led to welfare improvements, it is not clear whether this has been due to the regulator preventing price increases, or to the regulator transferring the benefits of lower system costs to consumer via external means. Experience appears to have varied. Truly independent regulation (from government as well as interest groups) is required for the latter, and this may not have been achieved in most of non-OECD Asia.*

- *Second, competition in generation (as opposed to monopoly) 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, which is increasingly popular in developing countries such as India.*

- *And finally, 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 for 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.*

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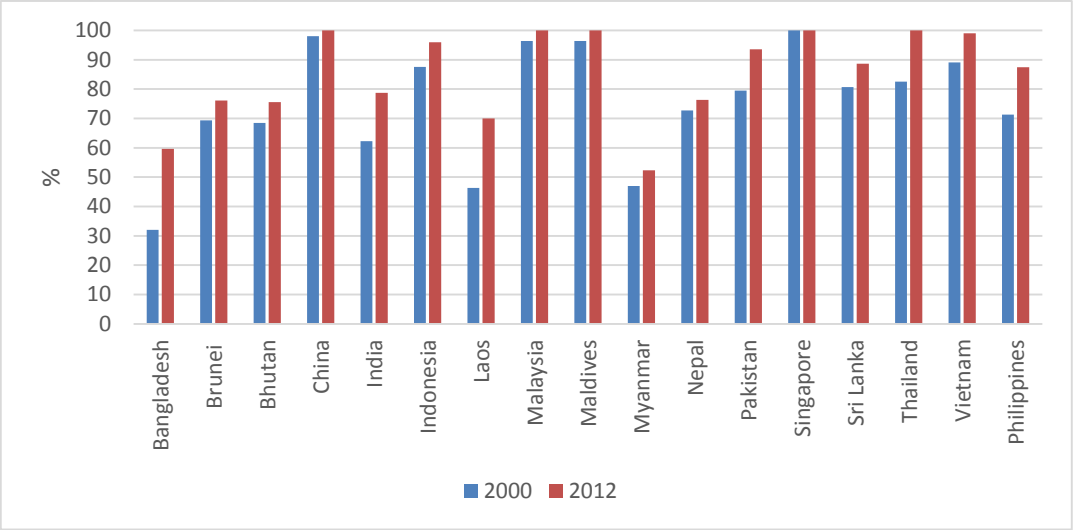
Appendix I: Post- estimation Tests

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

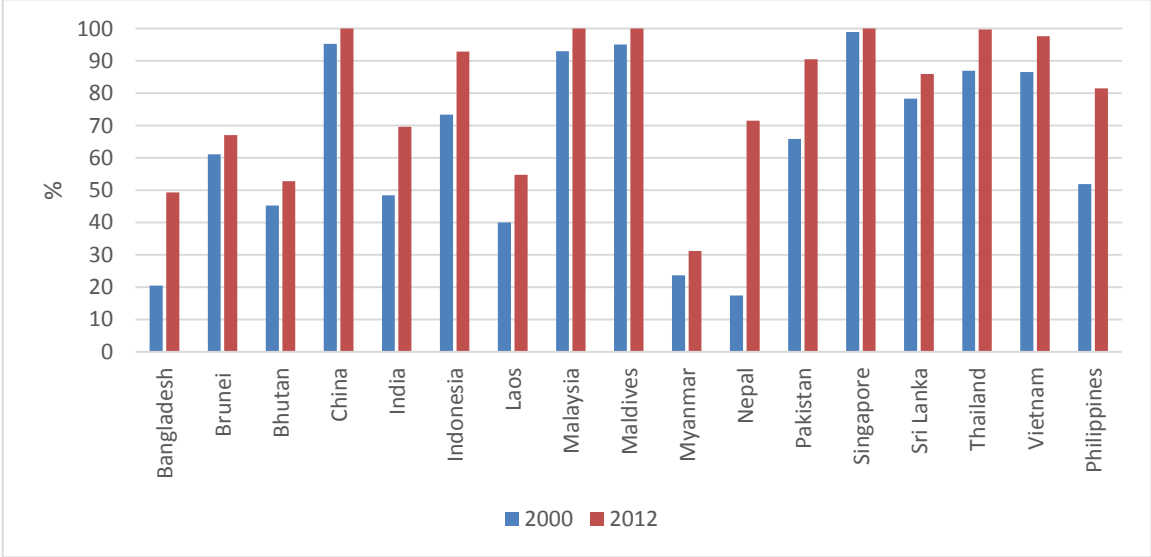
Appendix II: Percentages of Population with Electricity Access

A. Percentage of total population with electricity access, 2000 and 2012



Source: WDI (2015)

B. Percentage of rural population with electricity access, 2000 and 2012



Source: WDI (2015)

Appendix III: Descriptive Statistics

	lpgdp	lptdl	lphic	lpre	ltrade	lgini	lhdi	pr	cl	ipps	reg	unbldg	corp	otpacc~s	dprv
lpgdp	1														
lptdl	0.7344	1													
lphic	0.6538	0.8174	1												
lpre	0.7622	0.8871	0.6489	1											
ltrade	0.0189	0.0532	0.1807	0.0753	1										
lgini	0.4502	0.3682	0.1678	0.5877	0.1331	1									
lhdi	0.5801	0.5029	0.3923	0.6879	-0.0756	0.5766	1								
pr	-0.2166	0.0048	0.0512	0.1561	0.2347	-0.0483	0.1872	1							
cl	-0.2683	-0.0088	0.0779	0.1322	0.1148	-0.076	0.2258	0.9095	1						
ipps	-0.1268	-0.0977	-0.0746	-0.0885	0.0157	-0.3697	0.0885	0.1277	0.0513	1					
reg	0.063	0.19	0.1739	0.0038	-0.0351	-0.0045	0.0807	0.1344	0.0058	0.2303	1				
unbldg	0.0629	0.0769	0.081	-0.1142	-0.1023	-0.0754	-0.0368	-0.1967	-0.2124	0.2976	0.6012	1			
corp	0.2918	0.2142	0.1806	0.0183	-0.1891	0.1818	-0.0316	-0.5213	-0.5026	-0.1021	0.3626	0.7289	1		
otpaccess	0.5457	0.4094	0.2047	0.3857	-0.0076	0.1449	0.1779	-0.5632	-0.5572	0.14	-0.0829	0.2868	0.343	1	
dprv	-0.0516	0.2599	0.1003	0.0792	-0.1986	0.1	-0.0846	-0.4235	-0.4242	0.0754	0.3273	0.2533	0.1846	0.2744	1

Variable		Mean	Std. Dev.	Min	Max	Observations
lpgdp	overall	3.697974	0.5441898	2.089905	4.895911	N = 408
	between		0.5304478	2.712739	4.873994	n = 17
	within		0.175124	3.075141	4.225745	T = 24
lptdl	overall	10.87624	0.4833678	9.540918	12.06181	N = 408
	between		0.4545745	9.937747	11.55922	n = 17
	within		0.196682	10.29187	11.54354	T = 24
lphic	overall	4.120133	1.71306	0	6.585026	N = 408
	between		1.696914	0	5.994842	n = 17
	within		0.4666708	-1.821451	4.774575	T = 24
lpre	overall	5.243512	0.6275025	3.769156	6.40592	N = 408
	between		0.6212852	4.155065	6.319417	n = 17
	within		0.17198	4.763791	5.778677	T = 24
ltrade	overall	0.2429999	0.7288492	-1.403857	1.955736	N = 408
	between		0.7214044	-0.503831	1.899231	n = 17
	within		0.200516	-0.6570262	1.204175	T = 24
lgini	overall	1.576477	0.0693002	1.440909	1.797198	N = 82
	between		0.0577856	1.495218	1.660292	n = 16
	within		0.0369794	1.494938	1.721086	T = 5.125
lhdi	overall	-0.1802114	0.2855084	-0.4596705	2.884229	N = 131
	between		0.129284	-0.3220047	0.2606101	n = 18
	within		0.2539653	-0.6339635	2.443407	T-bar = 7.27778
pr	overall	4.845588	1.814	2	7	N = 408
	between		1.60962	2.333333	7	n = 17
	within		0.9198534	1.970588	8.387255	T = 24
cl	overall	4.764706	1.213572	3	7	N = 408
	between		1.097854	3.125	6.791667	n = 17
	within		0.5792975	2.973039	6.639706	T = 24

ipps	overall	0.7794118	0.4151524	0	1	N = 408
	between		0.2584361	0	1	n = 17
	within		0.3306609	-0.1789216	1.279412	T = 24
reg	overall	0.375	0.4847173	0	1	N = 408
	between		0.2366212	0	0.75	n = 17
	within		0.4267614	-0.375	1.333333	T = 24
unbldg	overall	0.370098	0.4834235	0	1	N = 408
	between		0.3165989	0	0.9166667	n = 17
	within		0.3729983	-0.5465686	1.203431	T = 24
corp	overall	0.5661765	0.4962098	0	1	N = 408
	between		0.3483153	0	1	n = 17
	within		0.3629831	-0.3504902	1.02451	T = 24
otpaccess	overall	0.1348039	0.3419333	0	1	N = 408
	between		0.2405007	0	0.6666667	n = 17
	within		0.2496927	-0.5318627	0.9264706	T = 24
dprv	overall	0.1568627	0.3641178	0	1	N = 408
	between		0.3013747	0	0.9166667	n = 17
	within		0.2165359	-0.7598039	0.6151961	T = 24