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The Role of Regulatory Governance in Driving PPPs in Electricity Transmission and Distribution in Developing Countries

A Cross-Country Analysis

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Abstract

This paper presents new global evidence on the key determinants of public-private partnership investment in electricity transmission and distribution, based on a panel data analysis of 105 developing countries over a period of 16 years from 1993 to 2008. It aims to identify the key factors affecting the private investor's decision to enter electricity transmission and distribution, through a probit analysis and the amount of investment sunk in this market segment, based on Heckman's sample selection analysis. One of the key results of the analysis is that sector regulatory governance affects only the entry of private investors in electricity transmission and distribution. It is not significantly linked to higher investment in transmission and distribution. The result implies that the power of the incentive has not been so strong as to affect the volume of investment. Similarly, economy-wide governance factors, including control for corruption and degree of political competition, are factored in by private investors only in the initial stage of the game when the decision to enter into the transmission and distribution market is taken. This reinforces the expectation that private investors seem to be adequately protected against risks, so that once they have entered the market, they can accommodate the governance environment. Finally, the introduction of renewables in the power system enhanced overall public-private partnership investment in transmission and distribution. Renewable-based energy also requires technical and regulatory certainty about the availability of renewable-ready transmission resources.

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A cross-country analysis

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JEL: L1, L51, Q48

Energy and Mining (EM) Sector Board

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1. Introduction

Attracting significantly higher private investment has been quoted as one of the most important reasons for the promotion of independent regulatory agencies in electricity both in the policy and academic arena. In addition, the existence of an effective regulatory framework can also encourage the growth of private investment and/or private finance within the public sector, as has been happening in recent years in India and China. Estimating whether regulatory agencies have significant impacts on private investment over time is important for the effectiveness of the policy.

Electricity distribution networks are highly capital intensive systems and timely investments to maintain and upgrade the assets are crucial for long-term reliability and expansion of their service. Much of the assets to transfer electricity (overhead lines, cables, switchgear, transformers, control systems and meters) have long economic lives and become sunk. Also, distribution networks have a diverse set of customers in terms usage level as well as consumption patterns. As demand for electricity service continues to increase the existing networks need to gradually be replaced and expanded and the electricity utilities requires additional investment.

The regulators are in a position where they decide what level of capital and operating expenditure is reasonable and also what the allowed rate of return should be on regulated assets. In distribution these three elements represent around one third each of the total regulated revenue.

What is the evidence of the effectiveness of regulatory governance to attract private investment in developing countries? This paper aims at determining among the key factors driving private sector investment in transmission and distribution, the role played by sectoral regulation and broader economy-wide governance factors.

The rest of the paper is organized as follows. Section 2 will undertake a short review of the literature on the role of regulatory governance and its impact on performance. Section 3 will highlight the key objectives of the papers and the data that is used to carry out the analysis. Section 3 introduces the theoretical hypotheses that will guide the empirical analysis. Section 4 reports the results of the regressions. Section 5 concludes and presents new directions for future research.

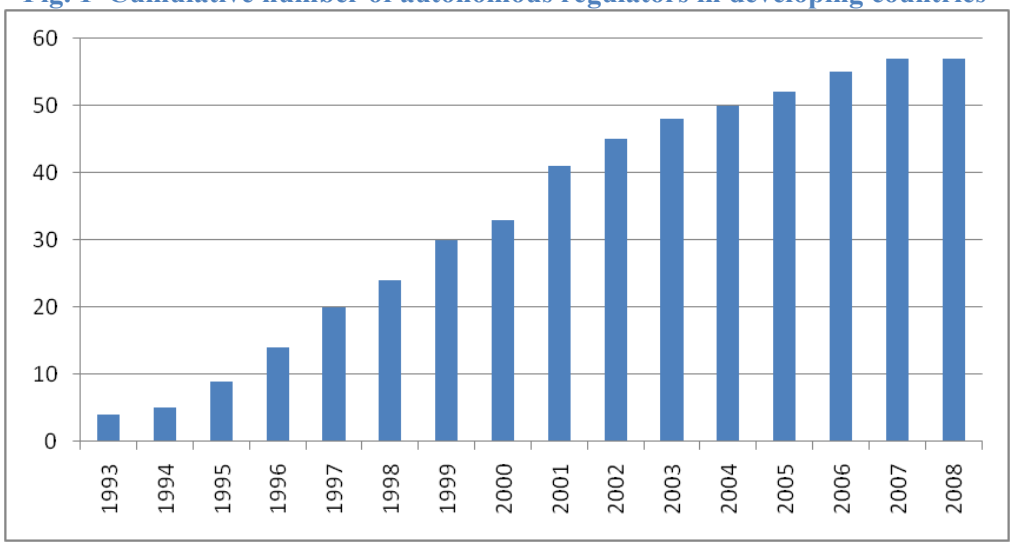
2. The role of regulatory governance

The main aim of electricity regulation is to provide utilities with incentives to improve their operating and investment efficiency and at the same time to ensure that consumers benefit from the gains. However, despite progress in economic regulation of networks in recent years, devising suitable incentives for network investments still remains a work in progress and a challenge for many regulators (see Joskow, 2008, Ofgem 2010).

As the number of developing countries that have established electricity regulators have been growing substantially and more data is becoming available on them that can be related to industry outcomes on a comparable basis. Fig 1 shows that the exponential growth of the

number of autonomous regulators among developing countries, raising from less than 10 in 1995 to about 60 in 2008.

Fig. 1 Cumulative number of autonomous regulators in developing countries



Source: Author's elaboration

The introduction of regulation, particularly incentive regulation regimes based on RPI-X models and benchmarking, has in most cases improved the efficiency of network utilities. The recent literature on regulatory governance for utility service industries has been pioneered by Levy and Spiller (1994). More recently there has been more systematic evidence that better regulatory governance increases efficiency.

Many recent studies show that having a regulatory agency is significantly associated, either directly or indirectly, with higher mainline capacity per capita and higher labor productivity. Cubbin and Stern (2006) made an econometric analysis of the relationship between the quality of regulatory governance and the level of generation capacity per capita and some efficiency measures for a sample of 28 Latin American, Caribbean, Asian and African countries over the period 1980-2001. Andres et al. (2008) suggested that the mere existence of a regulatory agency, regardless of the utilities' ownership, has a significant impact on performance.

The introduction of large amounts of (both large and small scale) renewables and gas-fired microgeneration into the electricity system may require substantial new investment in transmission and distribution networks. Elders *et al.* (2006) identify the following technologies as being potentially important in future transmission and distribution networks: new power electronics, flexible AC transmission system, storage facilities and superconducting lines.

Future networks will require more active management as the intermittency of renewable energy requires increased network management to mitigate some of the effects. The uncertainty of the timing, volume and location of new renewables also makes planning of network development more difficult than in the past and has implications for regulation.

3. Data

This paper presents new global evidence on the key determinants of public-private partnership (PPP) investment in electricity transmission and distribution based on a panel data analysis for 105 developing countries over a 16 years period from 1993 to 2008.

Our study aims to identify the key factors affecting the private investor's decision to enter electricity transmission and distribution and the amount of investment sunk in this market segment.

The analysis of the key determinants of the private investor's decision to enter is done using the probit model, where the dependent variable is a dummy equal to 1 if PPPs were introduced in electricity transmission and distribution and 0 if not.

The treatment of the modeling of the key factors affecting the private investor's amount of investment sunk in the renewable energy market is based on Heckman's approach to sample selection. This distinguishes between (1) the decision on whether to enter the generation segment of the electricity market (selection equation), and (2) the decision on how much investment to commit to (investment equation).[1] Unlike the Tobit model, the factors that affect the two decisions need not be identical and, where identical, could even be different in the sign of their effect on the decisions. The selection equation relates the choice of whether to attract PPPs (via a zero/one dummy variable) as a function of the governance variables and the price of oil is estimated over the complete set of countries using a probit model. The second-stage equation, relating PPP investment to the full set of short run and long run variables described in Table 1, is estimated over the sub-set of countries. Because the group has been selected by the first-stage equation, the possibility of selection bias would be introduced if a standard regression were used at the second stage. This bias is related to the magnitude of the correlation between the errors (that include the omitted variables) in the selection and investment equations. Where there is no correlation between these errors, there is no selection bias. The direction of the bias depends on the sign of the inter-equation error correlation.

The condition for identification of the Heckman estimation procedure is that the selection equation contains a significant variable(s) not included in the investment equation. The significance of the Mills' ratio in the second stage indicates whether there would have been selection bias in its absence. If the Mills' ratio is insignificant, a simple regression of the quantity of investment on explanatory variables would be unbiased. The canonical Heckman model also assumes that the errors are jointly normal. If that assumption fails, the estimator is generally inconsistent and can provide misleading inference in small samples.

Data used in this paper are composed of both micro and macro level data. The micro, project-level data are from the Private Participation in Infrastructure (PPI)[2] database. The PPI database is managed by the World Bank and the Private-Public Infrastructure Advisory Facility (PPIAF). The data are collected at the project level. The following information of each project recorded in

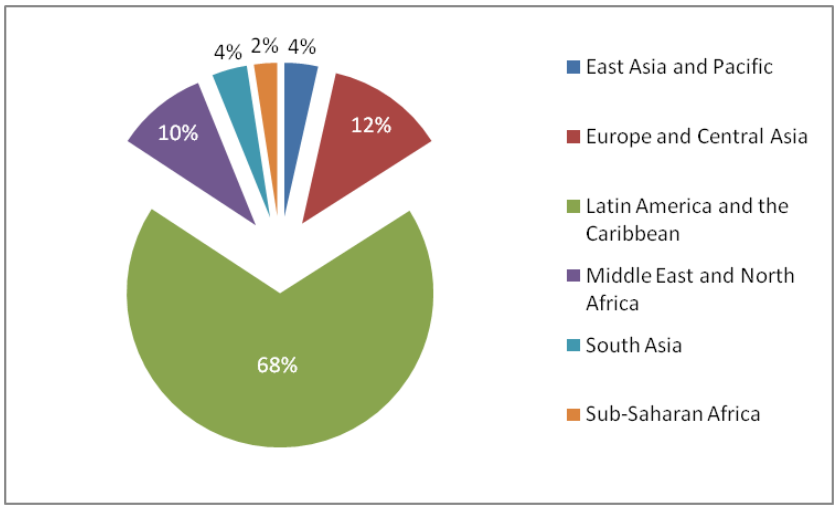
[1] The data on the dependent variable consist of observations related to the investment. This would be zero for countries that had not attracted PPPs, and positive for those countries that had decided to use it. This observation is split into two components: a zero or one variable indicating the lack of entry or entry of PPPs, and a variable measuring investment for the subset of countries that attracted PPPs.

[2] http://www.ppiaf.org/ppiaf/page/private-participation-infrastructure-database

the database is used in this paper: 1) country and region[3] 2) year of financial closure and total life period of the project, 3) total investment (in both monetary value and physical capacity, 4) sector, subsector, segment, and technology (source of energy) of each project.[4]

The macro data are collected from other central databases, including i) the *World Development Indicators (WDI) 2009* for macroeconomic variable and the *World Governance Indicators* and Polity IV to select few indicators of governance; and ii) the *Energy Balances and Statistics 2009* of the International Energy Agency (IEA) to derive indicators of energy import dependence and per capita CO_2 emissions and the electricity databases of the Energy Information Agency (EIA) of the US Department of Energy (DoE) (Annex 1) to countries' total installed capacity and their composition, total electricity generation, consumption, net import, and distribution losses. Finally, we also use publicly available information on the list of countries with an autonomous electricity regulator.

Fig. 2 Investment in Transmission and Distribution, by region



Source: World Bank/PPIAF PPI Database

As Figure 1 illustrates PPPs were very selective and the largest share of investment was attracted in the Latin America region. About 12% and 10% of investment in renewable took place respectively in the ECA and MNA region. Very little investments have been recorded in the remaining regions including EAP, SAR and SSA.

The trends over time in PPP investment in transmission and distribution (T&D) among developing countries confirm the exponential growth soon after reforms. Most of the PPPs in distribution took place in the second half of the 1990s, reaching a peak of about US$ 18,000 in 1997. Most of the PPPs in transmission took place in the second half of 2000, reaching a peak of about US$ 2,600 in 2006.

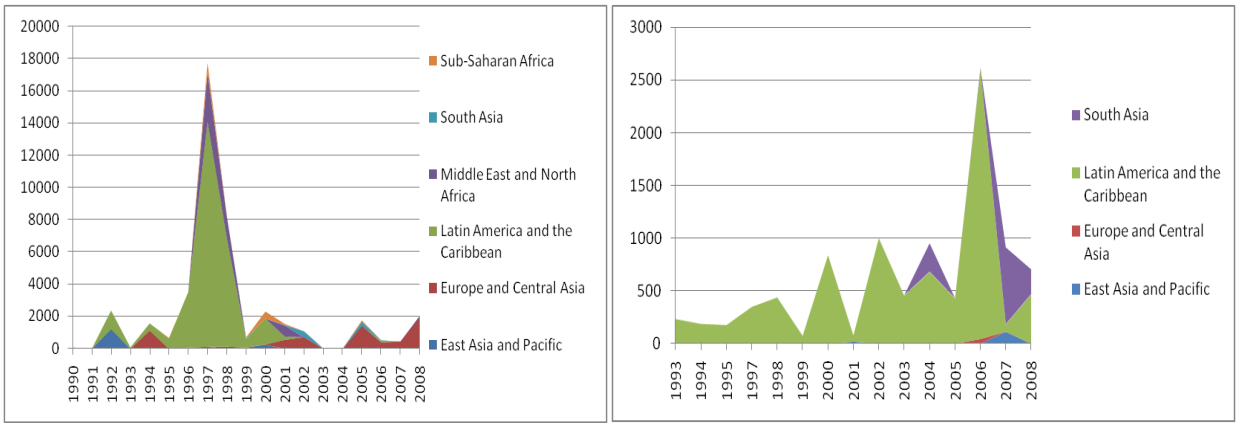
[3] The six regions are East Asia Pacific (EAP), East Europe and Central Asia (ECA), Latin America (LAC), Middle East and North Africa (MNA), South Asia Region (SAR), and Sub-Sahara Africa (SSA).

[4] The primary sector is energy, and the subsectors are electricity, natural gas, and other (road, telecom, or treatment plant). For the electricity subsector, the segment information tells whether it is a project for power generation, transmission, or distribution, or a combination of these. For power generation project, the technology (fuel) indicates what fuel (coal, oil, or natural gas etc.) or technology (hydro, wind, nuclear etc.) is used for the generation.

The regional trends reveal also specific features with decline soon after the financial crises. In the case of distribution most of the privatizations in Latin America took place in the 1990s and the peak of investment of about US$ 14,000 took place in 1997 (and accounted for about 80% of the total global PPP investment in distribution in the same year). Eastern Europe and Central Asia, following Latin America as the leader in PPP investment in distribution, had a peak of investment of about US$ 1,400 in 2005 (which also accounted for about 80% of the total global PPP investment in distribution in the same year). In the case of transmission most of the private sector participation in Latin America took place in the second half of 2000 and the peak of investment of about US$ 2,500 took place in 2006 (and accounted for more than 95% of the total global PPP investment in transmission in the same year). South Asia, the second region after Latin America in attracting PPP investment in transmission, had a peak of investment of about US$ 700 in 2007 (which accounted for about 80% of the total global PPP investment in transmission in the same year). The past financial crises, notably the East Asian and Russian crisis in 1997-1998 as well as the most recent Latin American crisis in 2001 have negatively affected PPP investment in T&D.

Fig. 3 PPP Investment in T&D, by region over time

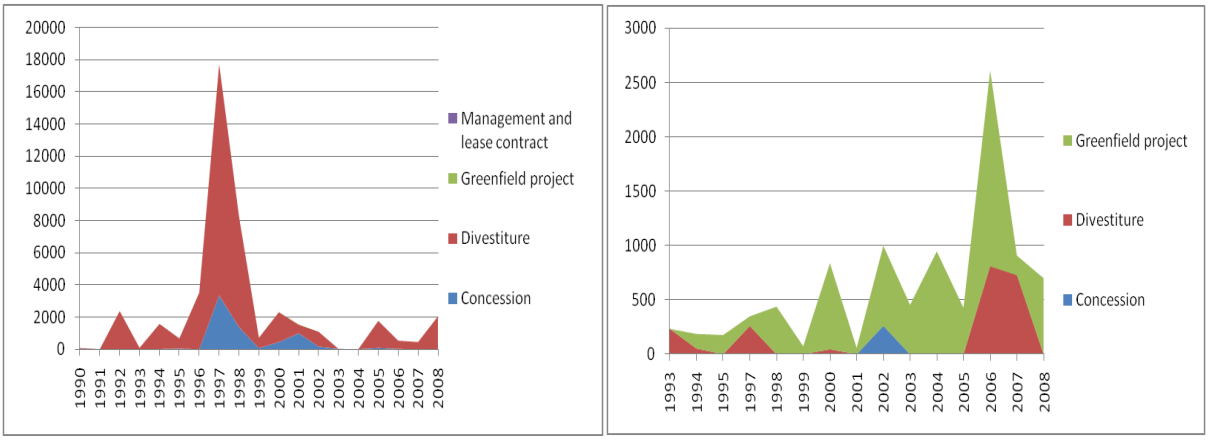
a) Distribution only *b) Transmission only*



Source: World Bank/PPIAF PPI Database

Fig. 4 PPP Investment in T&D, by types over time

a) Distribution only *b) Transmission only*



Source: World Bank/PPIAF PPI Database

The most prevalent form of PPP in distribution is by divestiture, where greenfield projects dominate in transmission. The types of PPPs also evolved over time. Up to the first half of the 1990s, PPPs in distribution took place only through the sale of stakes to strategic investors, whereas since the second half of the 1990s concessions also accounted for a sizeable proportion of PPPs (see Fig. 4).

Table 1
Explanatory Variables Influencing Private Investment in T&D
(Expected Relationship)

Variables	Definition	Exp. Sign
SECTORAL GOVERNANCE VARIABLES		
Introduction of a regulatory agency *REG*	= 1 since the year of establishment of a regulatory agency = 0 otherwise	+
Sequencing of policy (introduction of private sector first in distribution) *SEQU*	= 1 when PPPs have been introduced first in distribution and then in generation = 0 otherwise	+
ECONOMY WIDE GOVERNANCE VARIABLES		
Control of Corruption *wgi_cc*	= measures the perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. (Kaufmann and Kray World Governance Indicator)	+
Degree of democracy ***Polity2***	= Revised Combined Polity Score: This variable is a modified version of the POLITY variable to facilitate the use of the POLITY regime measure in time-series analyses. It ranges from +10 (strongly democratic) to -10 (strongly autocratic), based on 6 indicators.	+
SHORT RUN FINANCIAL CRISES		
East Asian and Russian Crisis *d_FC1*	= 1 for the 5 years after 1997 = 0 otherwise	-
Latin American Crisis *d_FC2*	= 1 for the 5 years after 2001 = 0 otherwise	-
LONG RUN MACROECONOMIC CONTROLS		
GDP per capita *ln_GDP*	= GDP per capita, PPP (constant 2005 international $ in logarithmic terms)	+
Population *ln_Pop*	= total population	+
ENVIRONMENTAL SUSTAINABILITY FACTORS		
PPP Investment in Renewables	= committed investment in renewables (US$ million)	+
REGIONAL CONTROL		
Region *d_region1, 2, 3,4,5,6*	Dummies , 1=EAP, 2=ECA, 3=LAC, 4=MNA, 5=SAR, 6=SSA	

We divide the determinants of PPPs into three channels, reported in Table 1. These include (sectoral and economy-wide) governance variables and short and long run drivers, represented respectively by financial crises and climate change variables. We also control for macroeconomic, sectoral and regional variables.

4. Theoretical hypotheses

The hypotheses that we are going to test are reported below. Each of the hypothesis is divided in two parts (part A and B), taking into account respectively the key factors affecting the private investor's decision to enter the renewable energy market and the amount of investment sunk in renewable energy, because of the different modeling that will be used (as described in Section 3).

Sectoral and Economy-Wide Governance

Hypothesis 1A The likelihood to attract private investors to provide investment in transmission and distribution is higher in countries where regulatory agencies have been put in place.

Hypothesis 1B The level of investment in transmission and distribution is expected to be higher in countries with regulatory agencies.

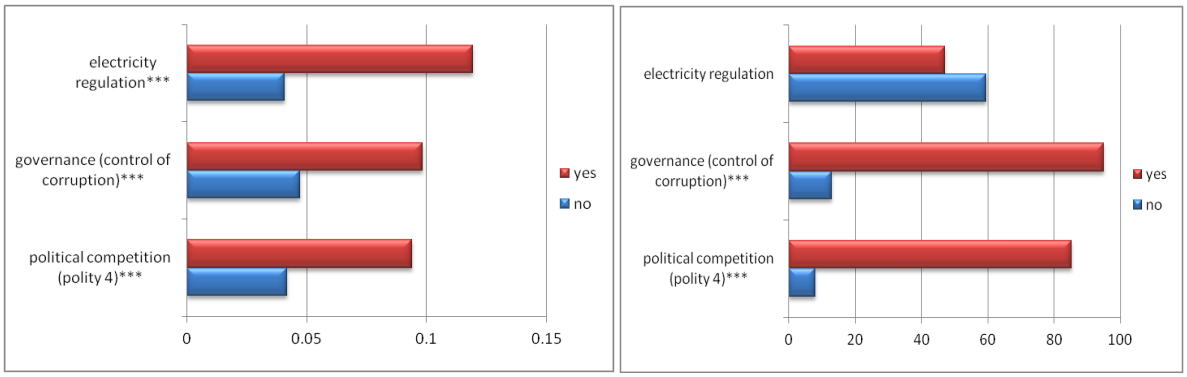
Electricity distribution networks are highly capital intensive systems and timely investments to maintain and upgrade the assets are crucial for long-term reliability and expansion of electricity services.

To get an initial indication of whether the data confirm these hypotheses we can calculate the two means between different groups (e.g. the proportion of investment for the observations where regulatory agency have been established and does where they were not to gauge the likelihood of investment) and compare them to see if one is greater than the other, and by how much. The significance of differences between two sample means can be assessed using the t-statistic calculated as part of the t-test. The t-statistic may be thought of as a scaled difference between the two means, where the absolute difference between means is rescaled using and estimate of the variability of the means. Such tests will be performed for each of the following hypotheses.

Fig. 5 illustrates the underlying trends in the data. Countries that have introduced a regulatory agency are three times more likely to attract private investment in T&D. Surprisingly they attracted less investment than countries where regulatory agencies have not been introduced, even if the difference in investment is not statistically significant.

Fig. 5
Links between Investment in T&D and Governance

a) Likelihood of attracting PPPs in T&D *b) Investment in PPP T&D (US$ million)*



Source: World Bank/PPIAF PPI Database
Note: *, **, *** indicate significance of the t test of the difference between the average respectively at 10%, 5% and 1% confidence level.

Hypothesis 2A The livelihood to attract private investors in T&D is higher in countries characterized by higher standards of economy-wide governance and a more democratic political system.

Hypothesis 2B The level of private investment in T&D is higher in countries characterized by higher standards of economy-wide governance and a more democratic political system.

Countries with above average economy wide indicators in terms of control of corruption and political competition are twice as likely to attract private investment. The difference in volume of investment is even more remarkable as countries to get more than 7 and 10 time the volume of investments for countries with higher indicators in terms of control of corruption and political competition.

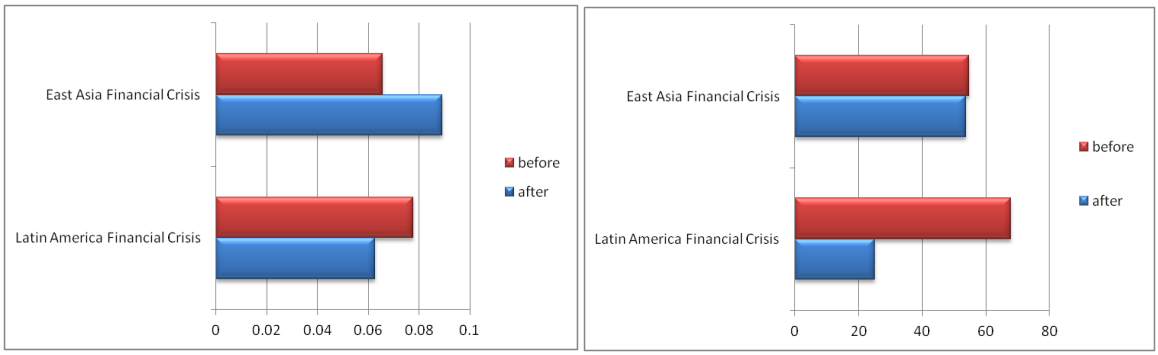
Short run crises and economic fundamentals

Hypothesis 3A Countries facing severe financial crises are more likely not to attract new PPPs in the few years following the crises.

Hypothesis 3B Countries facing severe financial crises are more likely to receive less PPP investment from existing PPPs in the few years following the crises.

The likelihood to attract investment declined by 20% after the Latin American financial crisis, but did marginally increase after the East Asian Crisis, but not significantly so. Investment dropped by 60 after the Latin American financial crisis, but did marginally increase after the East Asian Crisis. Not surprisingly the impact of the Latin American financial crisis was significant both in terms of likelihood and extent of reduction of investment.

Fig. 6
Links between Investment in T&D and Financial Crises
a) Likelihood of attracting PPPs in T&D *b) Investment in PPP in T&D (US$ million)*



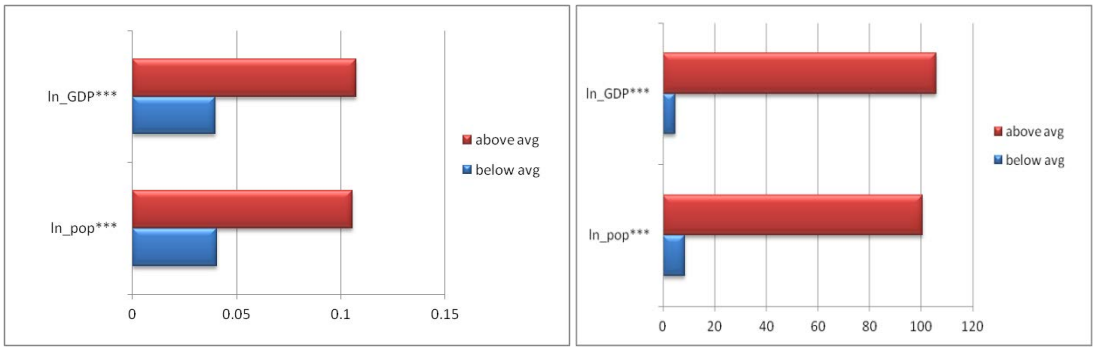
Source: World Bank/PPIAF PPI Database
Note: *, **, *** indicate significance of the t test of the difference between the average respectively at 10%, 5% and 1% confidence level.

Hypothesis 4A Countries characterized by higher income and size of the market are more likely to attract PPPs and a higher volume of investment.

Hypothesis 4B Countries characterized by higher income and size of the market are more likely to attract PPPs and a higher volume of investment.

Countries with above average GDP and population are respectively three times and twice more likely to attract investment in T&D. Countries with above average GDP and population attracted ten times more investment than countries whose population is increasing below the average, with both differences statistically significant at the 1% confidence level.

Fig. 7
Links between Investment in T&D and GDP per capita
a) Likelihood of attracting PPPs in T&D *b) Investment in PPP in T&D (US$ million)*



Source: World Bank/PPIAF PPI Database
Note: *, **, *** indicate significance of the t test of the difference between the average respectively at 10%, 5% and 1% confidence level.

Long run Environmental Sustainability Drivers

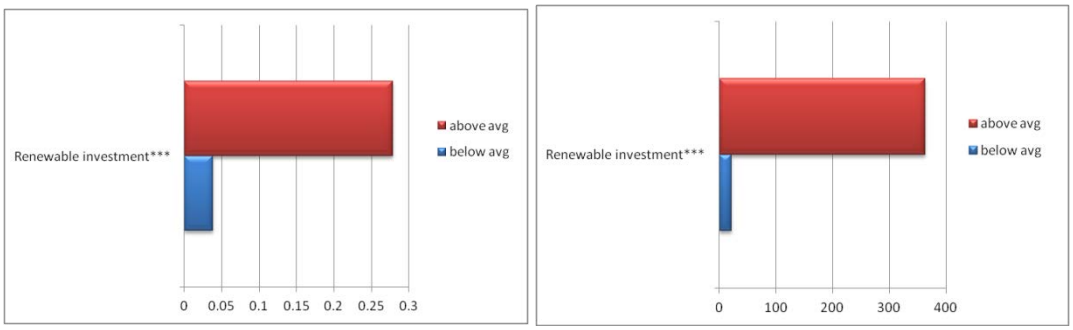
Hypothesis 5A Developing countries are integrating renewable energy into the system are more likely to attract more investment in T&D.

Hypothesis 5B Developing countries are integrating renewable energy into the system are more likely to retain more investment in T&D.

Developing countries have been ten times more likely to attract PPPs in T&D if they have introduced PPPs in renewable-based energy. They also attracted more 16 times the level of investment in T&D.

Fig. 8
Links between Investment in T&D and long run Environmental Factors

a) Likelihood of attracting PPPs in T&D *b) Investment in PPP in T&D (US$ million)*



Source: World Bank/PPIAF PPI Database
Note: *, **, *** indicate significance of the t test of the difference between the average respectively at 10%, 5% and 1% confidence level.

The results of the regressions will allow us to test the robustness of these initial findings.

5. Regression results

In this section the hypotheses that we put forward in the previous section are tested. Table 2 reports the parameter estimates using in the probit model as a dependent variable a dummy variable equal to 1 if PPP occurred for electricity T&D and 0 if not. Tables 3 and 4 compare the results for investment in transmission and distribution only.

Regression (1) reported in Table 2 represents the basic probit model introducing as explanatory variables the key sectoral and economy wide governance variables to test Hypotheses 1A and 2.A

Regressions 2-4 then extend the analysis to analyze the role of short run financial crises and long run climate change variables, controlling respectively for macroeconomic fundamental variables and sectoral control. Regression 3 also controls for regional dummies and add PPP investment in renewables.

Table 2 Key Determinants of Introduction of PPP in Transmission & Distribution

	(1)	(2)	(3)
GOVERNANCE VARIABLES			
SECTORAL GOVERNANCE VARIABLES			
Introduction of a regulatory agency *REG*	0.344*** (0.124)	0.354*** (0.131)	0.338*** (0.137)
Sequencing of policy (introduction of private sector first in distribution) *SEQU*	0.552*** (0.150)	0.368*** (0.157)	0.338*** (0.136)
ECONOMY WIDE GOVERNANCE VARIABLES			
Control of Corruption *wgi_cc*	0.244** (0.110)	0.238** (0.125)	0.101 (0.132)
Degree of democracy *Polity2*	0.032*** (0.012)	0.030** (0.013)	0.023* (0.014)
LONG RUN ENVIRONMENTAL SUSTAINABILITY FACTORS			
PPP Investment in Renewables			0.944*** (0.145)
MACROECONOMIC CONTROL			
GDP *ln_GDP*		0.033 (0.081)	0.059 (0.234)
Population *ln_Pop*		0.245*** (0.092)	0.146 (0.097)
REGIONAL CONTROLS			
LAC	-0.188*** (0.189)	-0.523*** (0.213)	-0.834*** (0.242)
Constant	-2.027*** (0.189)	-6.821*** (0.957)	-5.971 (1.012)
N	1185	1143	1143
Log likelihood	-287.62	-262.85	-241.84
χ^2	66.71***	109.41***	151.42***
Pseudo R^2	10.39	17.23	23.84

Note: *, **, *** indicate significance of the coefficient respectively at 10%, 5% and 1% confidence level.

In what follows the key results are highlighted, focusing on the specific hypotheses tested in each of the regressions.

Regression 1 confirms Hypothesis 1A with the introduction of regulatory agencies positively and highly significantly associated to the introduction of PPPs in T&D. Also Countries that attracted first PPPs in distribution and then in generation are also more likely to attract investment in distribution. Hypothesis 2A is however not confirmed with higher standard of economy wide governance making countries more likely to attract PPPs in T&D, but not significantly so. Sector governance dominates economy wide governance in attracting PPPs.

Regression 2 does not confirm Hypotheses 3A and 4A related to short run crises and economic fundamentals. Only the size of the market instead has both a positive and highly significant relationship with the introduction of PPPs.

Hypothesis 5A, on long run environmental factors, is confirmed with countries that have integrated renewable energy in their system more likely to attract PPPs in T&D. This confirms the importance of including considerations related to access to the grid and development of the network so as to integrate renewable-based energy into the power system. Because of the potential concerns with endogeneity due to the fact that private investment in both segments of the power sector can be driven by similar factors, we also used instrumental variables, including the lagged variable of PPP investment renewable-based generation variables. The results are robust to the introduction of instrumental variables.

Regression 3 confirms the robustness of the previous results controlling for regional dummies.

Table 3 Key Determinants of Introduction of PPP in Distribution

	(1)	(2)	(3)
GOVERNANCE VARIABLES			
SECTORAL GOVERNANCE VARIABLES			
Introduction of a regulatory agency *REG*	0.297** (0.148)	0.266* (0.154)	0.249* (0.156)
ECONOMY WIDE GOVERNANCE VARIABLES			
Control of Corruption *wgi_cc*	0.100 (0.135)	-0.043 (0.158)	-0.121 (0.164)
Degree of democracy ***Polity2***	0.064*** (0.017)	0.053*** (0.017)	0.050*** (0.017)
LONG RUN ENVIRONMENTAL SUSTAINABILITY FACTORS			
PPP Investment in Renewables			0.522*** (0.167)
MACROECONOMIC CONTROL			
GDP *ln_GDP*		0.241** (0.105)	0.250*** (0.109)
Population *ln_Pop*		-0.086 (0.114)	-0.148 (0.118)
Constant	-2.144*** (0.160)	-6.752*** (1.244)	-6.093*** (1.167)
N	1185	1143	1143
Log likelihood	-183.66	-174.58	-169.82
$\chi 2$	34.51***	49.12***	58.64***
Pseudo R2	8.59	12.33	14.72

Note: *, **, *** indicate significance of the coefficient respectively at 10%, 5% and 1% confidence level.

Most of the results also hold when the regressions are re-run for the separate components of investment in distribution and transmission only (Tables 3 and 4).

Table 4 Key Determinants of Introduction of PPP in Transmission

	(1)	(2)	(3)
GOVERNANCE VARIABLES			
SECTORAL GOVERNANCE VARIABLES			
Introduction of a regulatory agency *REG*	1.187*** (0.345)	1.358*** (0.404)	1.406*** (0.434)
ECONOMY WIDE GOVERNANCE VARIABLES			
Control of Corruption *wgi_cc*	0.084 (0.174)	- 0.093 (0.240)	-0.192 (0.223)
Degree of democracy ***Polity2***	0.076** (0.030)	0.070** (0.031)	0.074** (0.031)
LONG RUN ENVIRONMENTAL SUSTAINABILITY FACTORS			
PPP Renewable Investment			0.896*** (0.231)
MACROECONOMIC CONTROL			
GDP *ln_GDP*		0.397** (0.177)	0.533*** (0.204)
Population *ln_Pop*		0.405 (0.078)	0.240 (0.082)
Constant	-3.251*** (0.401)	-13.860*** (2.382)	-12.135*** (0.079)
N	1185	1143	1143
Log likelihood	-104.16	-85.20	-76.65
χ^2	49.27***	85.20***	102.32***
Pseudo R^2	19.13	33.34	40.03

Note: *, **, *** indicate significance of the coefficient respectively at 10%, 5% and 1% confidence level.

We can now move to determine which of the previous factors affect the private investor's decision to enter the market of renewable-based energy and the amount of investment sunk in the sector. Regressions (1) and (2) in Table 5 report the results of the two step Heckman model, introducing in the first stage as a dependent variable (reported in red) the likelihood of attracting private investment in T&D and as explanatory variables the key sectoral and economy wide governance variables. The second step of the model uses the logarithm of amount of private investment in T&D as the dependent variable, conditional on the decision to enter the renewable market, and as explanatory variables the broader model including the short run and long run variables described above. The final three regressions report the GLS model using as a dependent variable the logarithm of amount of private investment in T&D, which

restrict the number of observations only to countries with a non-negative level of private investment in T&D.

Table 5
Key Determinants of PPP Investment in Transmission and Distribution

	Two Step (1)	Two Step (2)	(3)
SECTORAL GOVERNANCE VARIABLES			
Introduction of a regulatory agency *REG* *First step in red*	0.427*** (0.121)	0.419*** (0.129)	
ECONOMY WIDE GOVERNANCE VARIABLES			
Control of Corruption *wgi_cc* *First step in red*	0.419* (0.244)	0.107 (0.116)	
Degree of democracy ***Polity2*** *First step in red*	0.037*** (0.012)	0.034*** (0.013)	
LONG RUN ENVIRONMENTAL SUSTAINABILITY FACTORS			
PPP in Renewables *First step in red*		0.943*** (0.138)	
Constant	-1.696*** (0.111)	-2.041*** (0.133)	
MACROECONOMIC CONTROL			
GDP *ln_GDP*	1.068*** (0.241)	1.032*** (0.221)	0.897*** (0.262)
Population *ln_Pop*	-0.874*** (0.257)	-0.860*** (0.228)	-0.697** (0.118)
Constant	-1.696*** (0.111)	-6.298** (3.207)	-6.201** (2.992)
N	1185	1185	91
Censored N	1094	1094	
Wald χ^2	22.59***	22.50***	14.33***
Within R^2			0.58
Between R^2			17.57
Overall R^2			26.35

Note: *, **, *** indicate significance of the coefficient respectively at 10%, 5% and 1% confidence level.

Some interesting results are worth highlighting. We will first focus on the different factors that affect entry and the level of investment in T&D.

First, sectoral and economy wide governance are crucial in attracting the entry of private investors, but they do not affect the extent of investment in the presence of substantial sharing of risks between the public and private sector. The sectoral economy wide governance

factors affect only the first step of the Heckman model, confirming the results of the probit model analyzed before. In other words, this suggests that before entering in the market private investor value regulatory certainty but once entered the tariff formula is guaranteed in the medium term in their contract so that the presence of an autonomous regulator does not impact the level of investment.

Other differences in results are more a question of nuances. In terms of economic fundamentals, whereas the level of entry was mainly affected by the market size (in terms of population), both income and population size affect the level of investment, highlighting the importance of affordability for investment in T&D. Financial crises do not affect the level of investment in T&D. Countries with higher renewable energy sources are not Higher emitter countries are more likely to attract more PPPs in T&D but with lower level of investments.

6. Conclusions

The data show some evidence of the relevance of regulatory governance in attracting and maintaining private investment.

The key results of the paper are summarized below:

- **Sectoral regulatory governance affects only the entry of private investors in electricity transmission and distribution. It is not significantly linked to higher investment in T&D.** The result implies that their incentive power has not been so strong as to affect the volume of investment. This suggests that the regulatory regimes have been more effective to reduce cost rather than encourage additional investment. The frequency of regulatory reviews is high with substantial changes implemented on an annual basis or even at quarterly basis. Multi-year prices are still an exception reducing the incentive power of regulatory rules. A variety of price control mechanisms related to technical dispatch constraints or market power mitigation procedures may also have a detrimental impact on investment incentives, particularly for peaking units which earn most of their revenues at periods of high prices (Stoft, 2002, Joskow, 2003, Joskow and Tirole, 2006).The traditional reactive model of transmission regulation that has been used in the past, where transmission has been developed on a first-come, first-served basis is not conducive for renewable-based energy, as it introduces extensive regulatory and technical uncertainty about whether adequate transmission will be available once the resource is generated, and transmission distances for renewable-based energy can be large.

- **Similarly, economy-wide governance factors, including control for corruption and degree of political competition are factored in by private investors only in the initial stage of the game when the decision to enter into the T&D market is taken. T**his reinforces our earlier suggestions that private investors seem to be adequately protected against their risks, so that once they have entered the market, they can accommodate the governance environment.

- **The introduction of renewables in the power system enhanced overall PPP investment in transmission and distribution.** Renewable-based energy also requires technical and regulatory certainty about the availability of renewable-ready transmission resources.

- **Short run financial crises did not affect the level of entry or the investment in T&D.** This proves the resilience of T&D private investment to such shocks.

- **Private investors entering the T&D market looks more at the size of the market rather than the income level, whereas when determining the level of investment in T&D they assess both the size and "affordability" level of consumers**.

Moving forward, some rethinking of the incentive of the regulatory system may be needed suggesting that the incentive formula needs to be overhauled in favor of a simpler yardstick based system and which allows for more merchant transmission investments. Future regulation could involve more negotiated regulation involving agreements between network owners and purchasers of network services. This would be particularly advantageous for decisions on new network investments. More extensive use may need to be made of locational pricing within the transmission and distribution system in order to facilitate the least cost expansion of low carbon generation, including micropower.

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