Are a developing country's levels of economic and financial development key attracting factors for private investment into infrastructure sectors?*

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Abstract

This paper seeks to assess the extent to which a developing country's levels of economic and financial development are factors that attract private capital into infrastructure projects. We investigate these effects by means of SYS-GMM estimation techniques applied to 1990-2007 data on the power sector concerning 56 developing countries in which missing observations are handled through multiple imputation by chained equations (MICE). We find that the volume of private investment in electricity projects significantly increases with both the depth of the banking sector and the efficiency of the stock market whereas no significant effect of economic development, as measured by the natural log of GDP per capita, is found. Private investors also take a country's institutional environment into account in their decisions to enter the power sector. While political, economic, and financial risk as captured in a country's risk index seems to dampen private investment, investors do not seem to be averse to exchange rate risk. The level of corruption is also found to positively affect private participation in the financing of energy projects. These results suggest that both exchange rate and corruption may have been used by private investors as instruments to increase their expected return and further protect their investment.

JEL-codes: L33, L38, L94, L97, C23
Key words: Infrastructure sectors, Public-private partnership, Power sector, Financial sector development, Economic growth, Dynamic panel data, Multiple data imputation.

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1. Introduction

In recent years, a host of developing countries has experienced robust economic growth but some observers have come to wonder whether to sustain such growth prospects these countries wouldn't need to significantly increase investment in infrastructure.[1] To bridge the investment gap they currently face, developing countries need both to improve the quality of public spending in infrastructure as well as to attract more private capital. Rapid urbanization and economic growth, demographic trends, and climate change are all but some of the challenges that developing countries have to face and that call for an acceleration of public and private investments to rehabilitate, upgrade, and expand their infrastructures.[2] Moreover, sustaining good quality of infrastructure service delivery requires a better composition of the infrastructure stock, a good level of maintenance, and an appropriate sequencing of institutional reforms across sectors including the financial sector.

Low or non-existent sovereign credit ratings and the absence of proper financial instruments to mitigate risks inherent to infrastructure projects are among the factors that limit private commitments in developing regions' infrastructure projects.[3] After a sharp decline from relatively high levels in the mid-90s, annual private investment in infrastructure in developing countries has stabilized in the 11-to-16 billion USD range since 2001 with a debt-equity distribution that varies significantly across regions. For instance, while bonds have become an important tool for financing infrastructure investments in the Latin America and East Asia regions, representing, during the 1996-2004 period, 29% and 14% of infrastructure financing respectively, bond financing is nearly non-existent in the Middle East and North Africa region where about 98% of private investments in infrastructure has been in the form of loans from banks.

Because they mobilize lumpy investment and deliver future gains in local currency, infrastructure projects financed with hard currency are exposed to currency devaluation and to the volatility of interest rates. Therefore, strengthening the capacity of local financial markets so they can extend debt and equity financing instruments denominated in local currency in competitive terms is crucial to accelerating private investment in infrastructure in developing countries. In the late 80s-early 90s, developing countries sought to develop their financial markets by implementing structural reforms

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[1]Yepes (2008) suggests that developing countries need to invest approximately 5 to 7 percent of their GDP in infrastructures to be able to maintain economic growth in the period 2008-2115 at their current average rate of 5 percent. For a survey on the relationship between infrastructure development and growth, see Straub (2008).

[2]Although public/government funds, private capital, and donors' aid all play a sizeable role in the financing of infrastructure projects, in this paper we focuse on the private participation in these projects.

[3]The experiences of Cameroon, Nigeria, and Tanzania have indeed shown how macroeconomic, institutional, and financial reforms can increase longer-term local currency financing for banks, and therefore progressively increase local bank financing for infrastructure projects.

including removing regulatory bottlenecks and rolling back the interventionist role of the state through privatization of commercial banks or by strengthening the independence of central banks.[4] In parallel, project sponsors have also attempted to increase the use of local currency loans in closing the financing of infrastructure projects in developing countries.[5] These efforts to develop appropriate local financial markets have however faced further difficulties due to the nature and profile of infrastructure projects (high economic stakes, long payback, and exposure to political interferences).

While the need for developing countries to foster investment in infrastructure sectors has been emphasized in the literature, the issue of these countries' limitations to attract private capital remains relatively weakly explored. This paper seeks to contribute to filling this void by testing whether the levels of economic and financial development of a country are good predictors of its ability to attract private investment into infrastructure projects when controlling for the quality of the institutional and regulatory environment. We specify regression models that we fit to a 1990-2007 annual dataset on the power sector in 56 developing countries. In addition to the main variables of interest, the first lag of the dependent variable is included as an independent variable in all models in order to capture potential dynamics.

Applying the Arellano-Bover (1995) and Blundell-Bond (1998) one-step System Generalized Method of Moments (SYS-GMM) approach for dynamic panel models to the data augmented through multiple imputation by chained equations (MICE), an increasingly popular approach for handling missing observations, we find that financial development unambiguously matters to private investors seeking to enter infrastructure sectors in developing countries. Indeed, the volume of private investment significantly increases with both the banking sector and stock markets' development while we find no significant effect of the level of economic development. As expected, quality of institutions and risk factors, such as overall country risk, exchange rate fluctuations and the level of corruption, are also found to influence private investors' decisions. Furthermore, our results highlight that private investment significantly increases with a poor quality of public investment in the power sector, suggesting that public and private investments are substitutes. Unexpectedly, we find that high real interest rates significantly enhance private participation in energy projects financing, hinting that high interest rates do not actually make investors withdraw from the power sector for more profitable projects. In contrast, we do not find evidence that the existence of an independent energy sector regulator fosters private investment in power projects.

This paper is organized as follows. The next section provides a review of the literature that

[4] See Huang (2006).

[5]Note, however, that these initiatives have only led to some local currency loans and bond issuances mainly concerning telecom projects.

discusses the role of infrastructure in development, its financing, and the determinants of private participation in infrastructure projects. Section 3 describes the data used and the main variables of interest and briefly discusses some of their properties. Section 4 presents the econometric approach used to analyze the data and section 5 reports the results. Section 6 concludes and the appendix gives further details on the data and some summary statistics.

2. Related literature

The importance of infrastructure development for poverty reduction and long-run economic growth in low-income and developing countries started being highlighted in the 90s, and this view has been since reinforced. The relationship between infrastructure development and economic growth has been characterized as one of a "virtuous circle" in the sense that a sustainable development in infrastructure is not possible without strong economic growth and growth is not possible without substantial improvements in the delivery of infrastructure services (The World Bank, 2006).[6]

As in most part of the world, infrastructure services were traditionally provided by stated-owned vertically integrated monopolies in developing countries.[7] This model became plagued by poor performance due to various factors including political interference, inefficient management, and under-investment. Under limited resources, the public sector alone in developing countries cannot ensure adequate infrastructure funding together with the operational activities necessary to effectively provide quality of service (Saidi, 2006). Consequently, existing infrastructures in developing countries need upgrading and modernization. This situation has made the financing of infrastructure projects even more challenging as demand for infrastructure services has substantially increased following population growth and large-scale urbanization.

To reduce the gap between infrastructure demand and supply in developing countries, partnerships between public and private sectors have been advocated. Public-Private Partnerships (PPPs) became one of the most popular financial mechanisms used to mobilize private capital for infrastructure financing. Local currency financing would have been preferred in most cases to avoid exposure to foreign exchange risk, whereas infrastructure projects with private participation are often financed with a mix of hard currency denominated equity and non-recourse debt.[8]

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[6]Infrastructure contributes to growth by enlarging markets, reducing trade barriers and economic risk of private investments, and increasing productivity, output, and employment (Prud'homme, 2005, Saidi, 2006). Infrastructure development also contributes to poverty reduction by enhancing the poor's access to local and foreign markets and providing them with better information on market opportunities and ways to improve their standards of living (Jerome, 2008).

[7]The public good nature of infrastructure services, the existence of externalities, and the incompleteness of markets are the main market failures invoked to justify state intervention (Calitz and Fourie, 2007). However, infrastructure services are increasingly becoming rival and excludable goods, therefore questioning the necessity of public intervention.

[8]The borrower of a non-recourse debt is typically a special-purpose entity (PPP) created to own an infrastructure project.

Partnerships between the public and private sectors were viewed as mechanisms that would allow gathering and channeling the needed amount of resources to sustain growth and alleviate poverty in developing countries (The World Bank, 2006). Consequently, many developing countries undertook large-scale reforms of their infrastructure sectors in the late 80s-early 90s with the goal of promoting competition through liberalization, improving regulation of the sectors, and involving private and foreign actors in infrastructure ownership, management, operations, and service provision. Despite these reforms, developing countries still have to enhance private sector involvement in infrastructure financing through the implementation of coordinated reforms in the financial sector.[9]

Stimulating private participation in the provision of public services is challenging, and even more so for low-income and developing countries. Projects design, risks identification and allocation, the availability of risk mitigation financial instruments, the institutional and regulatory framework, and the local financial markets' depth and composition are all but some of the key determinants of a country's ability to successfully mobilize private investment (Calitz and Fourie, 2007).[10] It is often argued that the difficulties of developing countries in attracting private investors in infrastructure sectors are essentially due to their poor or non-existent sovereign creditworthiness which partly can be explained by low income levels leading to low investor confidence in long-term policies, under-developed financial markets which do not offer enough capital and proper financial instruments, and high economic risk of infrastructure projects in these countries (Sheppard et al. 2006, Saidi, 2006, Jerome, 2008). All these factors alter private investors' confidence and therefore their investment decisions.[11]

Investors (shareholders) that own this entity have generally no responsibility to repay the debt used to finance the special-purpose entity. Shareholders often finance 20% of the project (in equity) and the remaining 80% is usually financed through a bank loan guaranteed by the government (through the PPP). If borrowers fail to reimburse, the only recourse for the bank is to "step in" the entity's management if the failure is due to a managerial problem. Collective bond issuances are also often used. They consist of a credible intermediary, such as the central government, which establishes a Bond Bank that collects all the borrowing needs of municipalities and issues a single class of bond backed up by a diversified pool of loans. Platz (2009) argues that a particular attention should be paid to sub-sovereign bonds, essentially issued in local currency, as a source of infrastructure financing instrument as they "… generally target domestic capital market investors who are more familiar with the local governments than international creditors ...".

[9]Between 1997 and 2004, developing countries received only a small share of private investment. Africa attracted less non-recourse debt than other regions and has been less successful in raising financing through bond issuance. Moreover, most of the bond financing in Africa during this period was for South-African projects through local currency issues in the local capital markets (Sheppard et al. 2006).

[10]The World Bank (2006) has highlighted that the susceptibility of projects to governance, corruption, and political interference may alter private investment and advocated the need for governments to implement anti-corruption instruments and improve governance and rule of law, including investors' protection. Jerome (2008) underlines the importance of institutional and fiscal reforms. Although the depth and composition of local capital markets significantly affects their ability to mobilize capital, their actual ability to provide infrastructure financing depends on other factors, including the size of the domestic economy, the level of per capita income, macroeconomic stability, and the development of contractual savings institutions such as pension funds and life insurance (Sheppard, 2006).

[11]For instance, only 16 of 48 African countries have foreign currency debt ratings and only 4 of these 16 have ratings that give relatively broad access to financial markets (BB- or higher). These 4 countries represent 43% of regional GNI (dominated by South Africa) while this share represents more than two third of regional GNI in other developing regions.

As indicated earlier, infrastructure projects are preferably financed with a combination of local currency bonds and non-recourse debt. The domestic financial sector's depth and composition are therefore key determinants of a country's attractiveness for private investors.[12] As infrastructure projects tend to be riskier than other sectors' projects, due to their longer payback and build-out periods and their exposure to political and regulatory risks, proper risk mitigating instruments are needed to improve investors' confidence. Moreover, developing and low-income countries are characterized by under-developed financial markets which essentially offer short-term local currency financing. These markets often involve only a small number of players therefore reducing competition, distorting yields, and ultimately leading to high transaction costs (Platz, 2009).[13]

In recent years, commercial banks in developing countries have gained increased exposure to non-recourse project financing in loans clubs or syndications led by major international banks. But, due to their difficulties to mobilize long-term finance, their overall ability to extend long term loans in local currency to infrastructure PPP projects is significantly impeded (Sheppard, 2006).[14] Furthermore, in most developing countries' bond and secondary markets are embryonic or non-existent, and cannot therefore offer financial and risk mitigating instruments required for infrastructure projects (Gupta et al., 2001). While many developing countries have implemented structural reforms to further deepen their financial and capital markets since the mid-late 90s, their financial sectors have not yet reached a level of development required to catalyze the development of private investment in infrastructure.

Some empirical studies have investigated the determinants of private investment in developing countries, but most of them consider private flows to the economy as a whole and not to specific infrastructure sectors. Moreover, to our knowledge, very few empirical analyses have investigated the attractiveness of a country's overall economic development level or financial development level to private investors in developing countries.

Pargal (2003) examines the effects of the regulatory framework on private investment in infrastructure in nine Latin American countries from 1980 to 1998 and finds that the investment regime's liberalization and the existence of independent regulatory agencies are the most significant institutional determinant of private investment. Banerjee et al. (2006) empirically study the

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[12]The OECD (2006) emphasizes the key role of financial markets development in promoting investment in infrastructure in the medium term.

[13]South Africa is an exception in Sub-Saharan Africa with a relatively well developed financial system capable of providing long-term local currency funding for infrastructure projects. Moreover, "… the government is a potential borrower of good standing, domestically and internationally, and has a significant borrowing capacity. Consequently, public-private partnerships have steadily developed in South Africa during the past 20 years." (Calitz and Fourie, 2007).

[14]Financial intermediaries facilitate transactions, allocate capital, and collect savings. Therefore, an under-developed financial system may prevent households accessing banks and other institutions to deposit their savings, which could be used for infrastructure financing. The most prominent low- and middle- income countries with domestic banks that are active in the project finance market are China, India, Malaysia, South Africa, and Thailand.

determinants of private investment in infrastructure using a panel dataset of 40 developing countries from 1990 to 2000. They find that property rights and bureaucratic quality significantly improve private investment while, surprisingly, countries with higher levels of corruption attract more private participation in infrastructure projects financing. Their results also emphasize that stock markets' development has a positive effect on private investment but this effect is negligible. Gjini et al. (2012) focus on the effect of public investment on private investment in the emerging economies in Eastern Europe from 1991 to 2009. Their results suggest that there is no crowding out effect of public investment on private investment in the East, and this is mainly due to the lack of market economy institutions, infrastructure, performance of the economy, and expectations. In contrast, Sahu and Panda (2012) find evidence that public investment crowds out private investment in the long run in India for the period 1970-2010.

Ouattara (2004) investigates the long-run determinants of private investment in Senegal from 1970 to 2000 and reaches the conclusion that public investment, GDP per capita, and foreign aid positively influence private investment. In contrast, credit to the private sector and terms of trade surprisingly tend to hinder private investment in Senegal. Likewise, Zerfu (2001) finds that GDP, its growth rate, and public investment in infrastructure significantly foster private investment in Ethiopia while lack of macroeconomic stability tend to negatively affect investment. Examining the determinants of infrastructure private investment in 61 developing countries over the period 1970-2003, Kinda (2008) also finds a significant positive effect of economic growth, physical infrastructure, and level of development of the financial sector, in particular, credit granted to the private sector by the banking sector. This author also finds, as in previous studies, that private investment is negatively influenced by macroeconomic and political instability. For the case of Ghana during the period 1970-1992, Asante (2000) finds that public investment, lagged private investment, and the growth of real credit to the private sector are key determinants of private investment. However, the author finds that the growth rate of GDP negatively influences private investment and so does macroeconomic and political instability.

3. The Data

To investigate the influence of a country's levels of overall economic and financial sector development on private investment in developing countries' power sector, we collected data on the 56 developing countries in Latin America and the Caribbean, Asia, Middle East and North Africa, and Sub-Saharan Africa shown in Table 1 below. Out of these 56 countries, 41 are middle income countries (MIC) and have high enough variance in their levels of economic development and active enough financial sectors so as to allow us to capture any potential effect of overall economic development and financial sector

development on private investment.[15] In addition, energy sector regulatory authorities have been created in a significant number of these countries during the period covered by our sample.

Table 2 below gives the list of variables on which data have been collected. More detailed information on these variables is given in Table A1 of the appendix. In the econometric analysis, the dependent variable, namely "Private capital in energy sector," is labeled *privinvt*. This variable represents the natural logarithm of the volume of private investment in power projects undertaken in a given country during a given year over that country's GDP deflator.[16]

As to the independent variables of interest, they are regrouped under the labels "Economic development" and "Financial sector development." Overall economic development is represented by the variable *gdppc*, the natural logarithm of GDP per capita. One would expect that countries with higher GDP per capita should be more appealing to private investors since higher income implies higher purchasing power and projected demand for infrastructure and should increase investment capacity (Pargal, 2003; Banerjee et al., 2006).

The variable *findev*, used to represent the level of development of a country's financial sector, is calculated as the first principal component of variables that represent the development level of the banking sector, *liqliab*, and the capital markets, *smt*.[17] Expressed as a fraction of GDP, the variable *liqliab* represents the liquid liabilities of domestic banks while *smt* is a market turnover variable meant to assess the stock market's efficiency. For a given year, it is calculated as the ratio of total value of traded shares to average market capitalization. As pointed out earlier, strengthening the capacity of local financial markets so they can extend debt and equity financing instruments denominated in local currency in competitive terms is crucial to accelerating private investment in infrastructure in developing countries. In this paper, we seek to test the hypothesis that financial development, resulting from structural reforms implemented in the late 80s-early 90s, has contributed to the improvement of the attractiveness of developing countries' power sector for private investment.

In addition to these variables, we use some indicators of the quality of a country's institutions, the level of risk, and the regulatory framework. A first group of variables, under the label "Institutional quality and risk" represents the country's level of political and economic risk (*countryrisk*), the country's exchange rate risk (*exchrisk*), and the degree of corruption in the country's government (*corruption*). High political, financial and economic as well as exchange risk are factors that may

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[15] A country is considered as lower middle income when its 2008 GNI per capita is between USD 976 and USD 3,855, a higher middle income country when its 2008 GNI per capita is between USD 3,856 and USD 11,905, and as a low income country when its GNI per capita is equal to USD 975 or less. As will be seen below, summary statistics show enough variance in the data so that selectivity bias shouldn't be a concern.

[16] In this paper, no distinction is made between domestic and foreign private investment.

[17] Our sole motivation for using these financial variables' first principal components is parameter parsimony and a sensitivity check exercise has been performed.

prevent investors from participating to infrastructure projects funding. In contrast, it is difficult to predict how investors will react to corruption. Indeed, private investors may be willing to avoid corrupt investment environments as corruption can be expected to worsen uncertainty and operational inefficiencies, and raise the cost of doing business. However, not entering a market is not always an option for multinational firms, especially in the particular case of infrastructure sectors where the first investor can earn a monopoly position. Furthermore, investors may bribe countries' local officials to further protect their investment (Banerjee et al., 2006). We also account for the way "Energy sector regulation" is structured through the use of a variable (*indepreg*) that informs us on the existence of an energy/electricity sector regulatory authority. The existence of an autonomous regulatory body should contribute to attracting more private capital as it implies a safer business environment.

Finally, two additional variables under the label "Control variables" are taken into account in our analysis. The first variable is the real interest rate (*intrate*) which is expected to negatively affect private investment as, if viewed as the real cost of engaging in an investment activity, an increase in real interest rates would make potential investors retreat from infrastructure projects which would lead to a decrease in private investment (Gjini et al., 2012; Pargal, 2003). The last variable is transmission and distribution losses as a share of total output used as a proxy of the quality of public investment in the power sector. The sign of the effect of public investment is ambiguous as the literature shows varying results regarding the crowding-in or crowding-out effects between public and private investments (Gjini et al., 2012; Sahu and Panda, 2012).

Table A2 given in the appendix exhibits some descriptive statistics on the variables.[18] During the 1990-2007 period, the developing countries included in the sample attracted private investment representing on average about 11% of their GDP (*privinvtgdp*). As to these countries' financial sector development, we see that domestic banks liquid liabilities (*liqliab*) represent 38% of GDP while stock markets' turnover (*smt*) mean reaches 29%.

[18]Data handling and econometric estimation have been carried out using Stata.

Table 1 - Countries in the sample

Country	World Bank Region	World Bank income group
Albania	Europe & Central Asia	Lower middle income
Algeria	Middle East & North Africa	Lower middle income
Argentina	Latin America & Caribbean	Upper middle income
Armenia	Europe & Central Asia	Lower middle income
Bangladesh	South Asia	Low income
Belize	Latin America & Caribbean	Upper middle income
Bolivia	Latin America & Caribbean	Lower middle income
Brazil	Latin America & Caribbean	Upper middle income
Cambodia	East Asia & Pacific	Low income
Cameroon	Sub-Saharan Africa	Lower middle income
Chile	Latin America & Caribbean	Upper middle income
China	East Asia & Pacific	Lower middle income
Colombia	Latin America & Caribbean	Lower middle income
Costa Rica	Latin America & Caribbean	Upper middle income
Cote d'Ivoire	Sub-Saharan Africa	Low income
Dominican Republic	Latin America & Caribbean	Lower middle income
Ecuador	Latin America & Caribbean	Lower middle income
Egypt	Middle East & North Africa	Lower middle income
El Salvador	Latin America & Caribbean	Lower middle income
Gabon	Sub-Saharan Africa	Upper middle income
Georgia	Europe & Central Asia	Lower middle income
Ghana	Sub-Saharan Africa	Low income
Grenada	Latin America & Caribbean	Upper middle income
Guatemala	Latin America & Caribbean	Lower middle income
India	South Asia	Lower middle income
Indonesia	East Asia & Pacific	Lower middle income
Jamaica	Latin America & Caribbean	Upper middle income
Kazakhstan	Middle East & North Africa	Lower middle income
Kenya	Sub-Saharan Africa	Low income
Latvia	Europe & Central Asia	Upper middle income
Lithuania	Europe & Central Asia	Upper middle income
Malaysia	East Asia and Pacific	Upper middle income
Mexico	Latin America & Caribbean	Upper middle income
Moldova	Europe and Central Asia	Lower middle income
Morocco	Middle East & North Africa	Lower middle income
Nepal	South Asia	Low income
Nigeria	Sub-Saharan Africa	Low income
Pakistan	South Asia	Low income
Panama	Latin America & Caribbean	Upper middle income
Peru	Latin America & Caribbean	Lower middle income
Philippines	East Asia and Pacific	Lower middle income
Senegal	Sub-Saharan Africa	Low income
South Africa	Sub-Saharan Africa	Upper middle income
Sri Lanka	South Asia	Lower middle income
Tanzania	Sub-Saharan Africa	Low income
Thailand	East Asia and Pacific	Lower middle income
Tunisia	Middle East & North Africa	Lower middle income
Turkey	Europe & Central Asia	Upper middle income
Uganda	Sub-Saharan Africa	Low income
Country	World Bank Region	World Bank income group
Ukraine	Europe & Central Asia	Lower middle income
Uruguay	Latin America & Caribbean	Upper middle income
Venezuela	Latin America & Caribbean	Upper middle income
Vietnam	East Asia & Pacific	Low income
Yemen	Middle East & North Africa	Low income
Zambia	Sub-Saharan Africa	Low income
Zimbabwe	Sub-Saharan Africa	Low income

Table 2 - Variables and designation

Variable/Index	Designation
Private capital in energy sector	
privinvt	Natural logarithm of the volume of private investment in energy projects to the GDP deflator
Economic development	
gdppc	Natural logarithm of GDP per capita
Financial development	
liqliab	Domestic banks liquid liabilities to GDP: measures the absolute size of the banking sector based on liabilities
smt	Stock market turnover ratio calculated as the ratio of value of shares traded during a period to average market capitalization: measures markets' efficiency
findev	Overall financial development
Institutional quality and risk	
corruption	Corruption
countryrisk	Country risk
exchrisk	Exchange rate risk
Energy sector regulation	
indepreg	Separated regulatory authority
Control variables	
intrate	Real interest rate (%)
tdlosses	Electricity transmission and distribution losses (% of output)

Simple correlation coefficients between the variable representing private investment in energy projects, *privinvt*, and the main variables are given in Table A3 of the appendix. The variables which positive (linear) relationship with private investment is captured through a relatively strong correlation coefficient are *findev*, *liqliab*, *smt*, and *countryrisk*. We however realize that these correlation coefficients give only some naïve indications on the sign and the magnitude of the relationships between our variables of interest. Consequently, we further investigate the robustness of these relationships by means of causality tests. More specifically, we ask whether there exists a causal relationship between private investment in developing countries' energy projects, the variable *privinvt*, on one hand, and the variables that proxy economic and financial development, *gdppc*, *liqliab*, *smt*, and *findev* on the other hand. To this end, we apply a standard Granger-type causality testing procedure suited for panel datasets (Hurlin, 2004). This procedure is built to test with a Wald statistic the "homogenous non causality (null) hypothesis" that a variable x *does not cause* a variable y. The alternative hypothesis encompasses the possibility that there exists a subset of individuals in the sample

with a causality relationship among its elements and another subset without. The results obtained confirm the existence of a causal relationship that runs from *gdppc*, *liqliab*, *smt*, and *findev* to *privinvt*, thereby suggesting that the former variables may be included as predictors of the latter variable in the econometric regression analysis to which we now turn.[19]

4. Econometric methodology

To evaluate how attractive to private investors a country's levels of economic and financial sector development are in developing countries' power sector, we run regressions where the natural logarithm of the level of annual private investment in energy projects over a GDP deflator is the dependent variable. In addition to the independent variables of main interest, namely, those used to proxy the levels of economic and financial sector development, we also include the first lag of the dependent variable in order to capture any potential dynamics. The set of right-hand variables of these regressions also comprises variables that capture some important features of the country's institutional and regulatory environment.[20]

Because the lagged dependent variable is correlated with the disturbance term, using the within-group estimator would yield biased estimates. As it is well known that the first-difference generalized method of moments (FD-GMM) may suffer from a weak instruments problem in case of strong persistency in the data, we apply the Arellano-Bover (1995) and Blundell-Bond (1998) one-step System Generalized Method of Moments (SYS-GMM) approach for dynamic panel models. However, while FD-GMM estimators are valid without regard to the data mean-stationarity, SYS-GMM estimators' consistency requires initial conditions to satisfy mean-stationarity. Hence, testing for mean-stationarity boils down to testing the validity of the instruments derived from the additional moment conditions used to construct SYS-GMM estimators. We therefore perform a test of over-identifying restrictions through a Hansen difference test (Dif-Hansen) of the null hypothesis that these instruments are exogenous.[21]

Furthermore, since the moment conditions used to estimate the models are valid only if there is no serial correlation in the idiosyncratic errors, an Arellano-Bond test of the hypothesis of no autocorrelation in the first-differenced errors and a Hansen-J test of the null hypothesis that moment conditions are valid are also performed for each model.[22] As pointed out earlier, the Dif-Hansen

[19]The Stata code used to perform these causality tests is the one contained in the working version of Zemcík (2011). Further details on the testing procedure and its application to our data are available from the authors upon request.

[20]Of particular interest to us is the role that the country's risk and institutions have played in building confidence of the private sector to fund energy projects.

[21] See Hayakawa and Nagata (2012) and Blundell and Bond (1998).

[22]While first-order autocorrelation is expected, rejecting the hypothesis of no serial correlation at higher orders implies that

statistic allows us to test that additional SYS-GMM moment conditions used are valid.[23] To avoid over-fitting bias, i.e., using too many moment conditions, we make sure to use a number of lags that keeps the number of instruments less than or equal to the number of groups used for the estimation.[24] The joint significance of the explanatory variables is tested with a Fisher test and endogeneity of the main variables of interest is addressed by means of a Hausman test and endogenous variables are instrumented.[25]

The econometric analysis is organized around two main objectives. A first objective is to examine whether overall economic development and financial sector development levels are good predictors of private investment. A second objective is to further explore the impact of the level of financial sector development by decomposing it into its banking sector and stock market components.

The first objective is tackled by means of regressions of the following general form:

$$privinvt_{it} = \alpha_1 privinvt_{it-1} + \alpha_2 gdppc_{it} + \alpha_3 findev_{it} + \mathrm{x}'\beta + \varepsilon_{it} \qquad (1)$$

where the indices $i = 1, 2, ..., 56$ and $t = 1, 2, ..., 18$ refer to the country and the year respectively, the variables *privinvt*, *gdppc*, and *findev* are as defined in the previous section, α_i, $i = 1,2,3,4$ are the associated coefficients, x is a vector of control variables that are presented in Table 2 under the labels "Institutional quality and risk," "Energy sector regulation," and "Control variables," β is the vector of associated coefficients, and ε is an error term.

To achieve the second objective, which is to further refine the analysis of the effect of the financial sector development on the volume of private investment in the power sector, we disaggregate the measure of the financial sector development level into its banking and stock market parts. Hence, we use the following general equation:

$$privinvt_{it} = \alpha_1 privinvt_{it-1} + \alpha_2 gdppc_{it} + \alpha_3 liqliab_{it} + \alpha_4 smt_{it} + \mathrm{x}'\beta + \varepsilon_{it} \qquad (2)$$

where all variables are as defined in section 3 above.

SYS-GMM is ideally designed for small T (number of periods) and large N (number of countries) panels. However, the number of countries in our sample is admittedly small due to unavailability of data for some variables, in particular, private investment. Soto (2009) has investigated the properties of SYS-GMM estimators for panel data when the number of individuals is small.

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instruments are not valid. Note that Hansen-J test results are robust but can be weakened by the use of too many instruments.

[23] We present Dif-Hansen results instead of Dif-Sargan as the latter is not robust with the estimation method used.

[24] See Soto (2009).

[25] We use Stata command xtabond2 which allows handling both exogenous and endogenous covariates.

Provided that some "persistency" feature is present in the series, this author uses Monte-Carlo simulations and finds that a small number of individuals does not seem to significantly alter the properties of the SYS-GMM estimator. The GMM estimator turns out to have a lower bias and is more efficient than standard estimators, including OLS, fixed effects, and first-difference GMM estimators. This said, we still fill in missing observations using multiple imputation, an increasingly popular approach for handling missing data, and carry out our analysis with the augmented data.

Multiple imputation (MI) consists in filling in missing observations to create several imputed datasets, each of which containing different imputed values. This method assumes observations to be missing at random, i.e., that the probability that a given variable has missing values may depend on anything that is observed but not on any of the unobserved values of the variables with missing data. It has three main steps. First, a series of imputed datasets is created based on specified imputation models. Second, the analysis of a statistical model is carried out using each of the imputed datasets. Finally, these analyses are pooled to generate a single set of results by applying some procedures known as "Rubin's rules" (Rubin, 1987). The retained parameter estimates are then the means of the estimates obtained with each imputed dataset. As to the standard error of a parameter, it contains two components, the within imputation variance, which is equal to the average of variances across imputations, and the between imputation variance, corresponding to a function of the variances of parameter estimates across the imputed datasets and the number of imputations.[26]

Two main approaches have been proposed in the literature for model-based MI. The first one (see Schafer, 1997) assumes that the joint distribution of all variables in the imputation model is a multivariate normal (MVNI) and uses a Markov chain Monte Carlo algorithm to impute missing observations from the estimated multivariate normal distribution, allowing for uncertainty in the estimated parameters of the model. In other words, variables with missing observations are imputed using information from all other variables based on a single model. The second approach, independently developed by van Buuren et al. (1999) and Raghunathan et al. (1996, 2001), is based on conditional densities of each of the variables given the other variables. This methodology, also known as "Multiple imputation by chained equations" (MICE), is considered as being more flexible than MVNI in the sense that it does not rely on the assumption of multivariate normality and it allows for a proper tailoring of imputation models depending on the type of variables. Indeed, a regression model is specified for each variable with missing observations conditionally on all the other variables in the imputation model. Imputations are then generated by estimating each specified regression model using

[26]Compared to single imputation, the main advantage of multiple imputation is that it allows accounting for missing data uncertainty through the between imputation variance, thereby leading to unbiased errors. Unfortunately, many statistical post-estimation procedures, such as likelihood ratio test or goodness of fit, are not directly applicable after MI.

observed values of the variable of interest and imputed values of other variables at each iteration allowing for uncertainty in the parameters. Another known advantage of MICE over MVNI is that, because it estimates a series of univariate regression models, it may accommodate larger imputation models.

In this paper missing observations are imputed by applying the more flexible approach MICE using the Stata user-written commands *ICE* and *MIM* implemented in Royston et al. (2004, 2005a, 2005b, 2007, 2009). More specifically, we apply the "Multiple imputation, then deletion" approach which consists in including the dependent variable in the imputation models but then deleting its imputed values before the analysis not to add noise to the estimation results (von Hippel, 2007). As suggested in the Stata manual recommendations, we set the number of imputations *m* to 50 and, prior to imputing missing values, we select each variable's predictors using the Stata user-written command *PRED_EQ* to not only use the maximum amount of available information but also remove any collinearity problem that may plague the predictors (Meideros, 2007). The quality of our imputations is then assessed by comparing the summary statistics of imputed variables with those of the original indicators.

5. Empirical analysis

In this section, we present the results of the econometric analysis of the effects of economic and financial development on developing countries' power sector's attractiveness to private investors, accounting for institutional and risk factors. We performed the imputation procedure with a number of imputations *m* equal to 50.[27] Furthermore, since not all developing countries within our sample actually have a stock market, we do not impute the variable *smt*.

We found that the imputation models are rather accurate as the original variables' summary statistics do not significantly vary when imputed values are accounted for. Moreover, as shown by the resulting number of observations, all missing values of all variables are imputed except *findev* due to the stock market variable's missing observations. As an illustration, Table 3 below presents summary statistics of the main variables of interest that have been imputed with $m = 1$ and $m = 50$.[28] In what follows, we therefore report estimation results of our regression analysis only with the imputed datasets.[29]

[27]Details on variables' imputation are available from the authors upon request.
[28]The financial development index, defined as the first principal component of financial variables, was re-computed in each dataset after the imputation of the banking sector variable.
[29] As expected, we find that MICE improves upon the estimation results obtained with the original data which are available from the authors upon request.

Table 3 - Quality of imputations

	Original dataset			Imputed dataset (m=1)			Imputed dataset (m=50)		
Variable	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.
gddpc	1005	7.150	1.010	1008	7.146	1.011	1008	7.148	1.010
liqliab	889	.384	.233	1008	.383	.236	1008	.371	.237
findev	626	-5.60e-10	1.072	685	.023	1.051	685	3.10e-10	1.039
intrate	786	12.245	32.836	1008	12.552	31.167	1008	11.787	31.090
tdlosses	949	16.915	8.980	1008	16.644	8.965	1008	16.856	8.934
countryrisk	868	65	8.490	1008	65	9.765	1008	65	11.896
exchrisk	878	8	2.177	1008	8	2.314	1008	8	2.598
corruption	868	2	.900	1008	2	9.975	1008	2	5.021

We now move on to presenting empirical results of our analysis of the effects of economic and financial development on private investment in energy projects. Regressions models presented in the previous section are analyzed with the augmented data. Tables 4 and 5 below give the one-step SYS-GMM parameter estimates of equation (1) while Tables 6 and 7 report results estimates of the parameters of equation (2).[30] Part from parameter estimates, the tables also report the number of observations actually used to estimate each model and the number of lags used as instruments. Moreover, to give some indication on the overall validity of the estimation results, these tables report some statistics obtained in the analysis of the original data. These include Fisher F statistic testing the joint significance of the independent variables, Arellano-Bond first and second autocorrelation coefficients of the first-differenced residuals, the Hansen J statistic for testing the validity of instruments, and the Dif-Hansen statistic allowing testing the validity of the additional SYS-GMM moment conditions.[31] We see that the lagged dependent variable is associated to a positive coefficient and is statistically significant in all models, thereby confirming the presence of a dynamic structure in the flow of private electricity projects funding. The results of regression models mostly confirm our intuition.

As can be seen from Table 4, financial sector development significantly influences private investment in developing countries' power projects as the index *findev* is significantly and positively related to private investment. As to economic development, its effect is positive but statistically

[30] We indicate by *, **, and *** respectively significance at the 10%, 5%, and 1% level. The results give robust standard errors.

[31] Second-order autocorrelation is rejected in most of the models and variables lagged two or more periods are used as instruments. Furthermore, the J statistic does not reject the validity of instruments in all models and the Dif-Hansen statistic validates the additional SYS-GMM moment conditions. Finally, Hausman test results show that economic and financial development variables are exogenous in most of the models. In the cases where some right-hand side variables, in particular, institutional ones were found to be significantly endogenous, those were instrumented. For a treatment of the endogeneity of institutional variables in infrastructure sectors, see Gasmi et al. (2009).

insignificant, hinting that it is not a good signal of private investors' decision to commit in developing countries' electricity projects. The results also show that countries that are less risky from a political, economic, and financial perspective attract more private capital for their energy projects financing. Interestingly, we find that private investors contributing to energy projects funding are risk lovers as far as exchange rates are concerned and seem to appreciate higher levels of corruption in the economy. Surprisingly, we find that the higher real interest rates the higher private investment suggesting that high interest rates do not make investors withdraw from infrastructure projects' financing. Similarly, private investment increases with transmission and distribution losses indicating that the lower the quality of public investment in the power sector, the higher private investors' participation in projects funding.[32]

Table 4 - SYS-GMM parameter estimates

Variable	Coefficient	Std error
lag(privinvt)	.345444**	.15034
gdppc	.029973	.158587
findev	.401693***	.14677
intrate	.04063***	.013174
tdlosses	.063076***	.022676
corruption	-.484591***	.139217
countryrisk	.184734***	.04179
exchrisk	-.179497***	.063594
Obs.	215	
m	50	
Nb lags	2	
Fisher test	F(8, 30) = 10879.76***	
Arellano Bond test - Order 1	-2.22**	
Arellano Bond test - Order 2	1.03	
Hansen-J	chi2(23) = 11.02	
Dif-Hansen	chi2(12) = 3.24	

When investigating whether the existence of an autonomous energy regulator matters for private investors by adding the variable *indepreg* as an independent variable in the previous model, our previous findings remain unchanged (Table 5). Indeed, the financial development variable *findev* still significantly fosters private investment in power projects while the effect of economic development is statistically insignificant. Estimation results also confirm the significant effects of *countryrisk*, *exchrisk* and *corruption*. Likewise, the control variables *intrate* and *tdlosses* still significantly increase private investment in energy projects. As to the existence of an autonomous energy regulator, our results suggest that it does not really matter for private investors since the variable *indepreg* does not significantly affect the dependent variable *privinvt*. Overall, it appears that developing countries'

[32] Note that this conclusion rests on the commonly used assumption in the literature that the efficiency of transmission and distribution networks is a reasonable proxy for the quality of public investment.

domestic financial sector's development, their institutional framework, more specifically the level of political, economic and financial risk and corruption, are all but important determinants of private investment in these countries' power sector projects.

Table 5 - SYS-GMM parameter estimates

Variable	Coefficient	Std error
lag(privinvt)	.326113**	.14568
gdppc	.088514	.170381
findev	.395068**	.152904
intrate	.04243***	.013735
tdlosses	.064639***	.023623
corruption	-.484576***	.138152
countryrisk	.182589***	.04099
exchrisk	-.154018**	.06078
indepreg	-.331721	.311459
Obs.	215	
m	50	
Nb lags	2	
Fisher test	F(9, 30) = 6890.21***	
Arellano Bond test - Order 1	-2.24**	
Arellano Bond test - Order 2	1.06	
Hansen-J	chi2(23) = 14.87	
Dif-Hansen	chi2(12) = 7.85	

The results discussed so far indicate that it is more the level of development of the financial sector than overall economic development that private investors regard as the key attracting factor when deciding on the volume of investment they allocate to developing countries' energy projects. More specifically, our analysis has shown that countries with a deeper financial sector attract more private capital. To determine which of the banking sector or stock market matters the most, we disaggregate the index *findev* into its components *liqliab* and *smt* and express private investment as a function of these variables and *gdppc* as described by equation (2) and apply the same methodology as previously. Tables 6 and 7 present our empirical results. Again, the results support the proposition that it is the state of development of the financial sector rather than economic development that matters for private investors.

The analysis which results are presented in Table 6 focuses on the effects of overall economic development and the level of development of the banking sector and capital markets on the attractiveness of developing countries' energy projects for private investors. As in model (1), although positive, the effect of economic development is not significant. We find that both the banking sector's depth and stock market's efficiency are positively and significantly related to private investment, confirming that both sub-sectors' levels of development are key determinants of developing countries' energy projects attractiveness for private investors. As to institutional and risk variables, our results show that overall country risk has a significant adverse effect on private investors' participation in

energy projects funding whereas high corruption and exchange risk significantly increases private investment. An interpretation of these results is that, although the overall level of a developing country's risk tends to dampen private investment, knowing that they can bribe local authorities to further protect their investment in energy projects seems to reassure private investors. Our findings also hint that investors likely to commit in these projects' funding are willing to bear more exchange risk to increase their expected return. The results also show that the cost of capital and the quality of public investment are factors that significantly affect private investment as, respectively, a higher real interest rate and a lower quality of the power network lead to higher private participation in power projects.

Table 6 - SYS-GMM parameter estimates

Variable	Coefficient	Std error
lag(privinvt)	.324882**	.148334
gdppc	.013977	.160589
liqliab	1.95433*	.985147
smt	.503431**	.205942
intrate	.04182***	.013244
tdlosses	.064596**	.026075
corruption	-.463678***	.141109
countryrisk	.175819***	.040102
exchrisk	-.172185**	.06481
Obs.	215	
m	50	
Nb lags	2	
Fisher test	F(9, 30) = 5469.29***	
Arellano Bond test - Order 1	-2.17**	
Arellano Bond test - Order 2	1.00	
Hansen-J	chi2(23) = 14.84	
Dif-Hansen	chi2(12) = 5.96	

While the results exhibited in Table 6 are interesting by themselves as they confirm most of our intuitions, as discussed earlier in the paper, besides uncovering the attractiveness of the economic and financial sector development of a country to potential private investors, we are also interested in the effect of the existence of an independent regulatory body in the energy sector. Table 7 below present results obtained when we estimate the economic and financial development effects while controlling for the existence of an independent regulatory authority in the energy sector. We see that our previous findings remain unchanged, in particular, the effect of financial development. Furthermore, our results suggest that the existence of an independent sector regulator is not an important determinant of developing countries' energy projects attractiveness for private investors. It therefore seems that it is the levels of development of the banking sector and the stock market that matter for private investors, along with the institutional environment, the cost of capital and the quality of public investment, rather than economic development or the energy sector regulatory framework.

Table 7 - SYS-GMM parameter estimates

Variable	Coefficient	Std error
lag(privinvt)	.312081**	.14617
gdppc	.05963	.167636
liqliab	1.91331*	1.02777
smt	.497212**	.21454
intrate	.043328***	.013691
tdlosses	.065316**	.026836
corruption	-.463041***	.140827
countryrisk	.173493***	.039959
exchrisk	-.148472**	.061163
indepreg	-.265246	.312281
Obs.	215	
m	50	
Nb lags	2	
Fisher test	F(10, 30) = 3514.02***	
Arellano Bond test - Order 1	-2.20**	
Arellano Bond test - Order 2	1.04	
Hansen-J	chi2(23) = 14.89	
Dif-Hansen	chi2(12) = 6.99	

6. Conclusion

This paper has set the objective of empirically investigating the determinants of private investment in developing countries' power projects, seeking to emphasize the importance of economic and financial sector development, accounting for some institutional and risk factors that may influence the private sector's investment decisions. Our dataset consists in a time-series-cross-sectional database on 56 developing countries from 1990 to 2007 in which missing observation values are filled using multiple imputation by chained equations (MICE). To account for dynamics we specify regression models comprising the first lag of the dependent variable as an explanatory variable and apply the Arellano-Bover (1995) and Blundell-Bond (1998) one-step System Generalized Method of Moments (SYS-GMM) approach for dynamic panel models.

Our empirical analysis of the augmented dataset has shown that financial development is a key determinant of the attractiveness of power projects to private investors. Indeed, a well-established and developed banking sector and an efficient stock market significantly foster private participation in developing countries' energy projects. In contrast, although positive, the effect of economic development is not statistically significant hinting that this variable is not an important attracting factor for private investors in the energy sector. Our findings also show that private investors account for countries' institutional development and risk factors when making their decision to enter infrastructure sectors. More importantly, our analysis has shown that country risk is the most important risk factor that keeps private investors from participating in power projects in developing countries whereas the levels of corruption and exchange risk seem to boost private participation, suggesting that investors

likely to contribute to developing countries' energy projects' financing are not fully risk averse and use exchange rate and corruption as instruments to increase their expected return and further protect their investment. Our results also highlight that private investment significantly increases with a poor quality of public investment in the power sector, suggesting that, to some extent, public and private investments are substitutes, although this result should be interpreted with caution. Unexpectedly, we find that high interest rates do not actually make investors withdraw from energy projects financing to the benefit of more profitable projects. Finally, we find no evidence that the existence of an autonomous energy sector regulator contributes to improving the private sector's involvement in power projects' funding.

Overall, our empirical results highlight that private participation in infrastructure projects is higher in countries with a more developed financial sector, lower political, economic and financial risk, high levels of corruption and exchange risk, and higher interest rates. Therefore, in their effort to attract more private capital for projects' financing, policy makers in developing countries should pay a particular attention to alleviating economic uncertainty while also deepening their domestic banking sector and stock markets. In a future research, we will investigate the combined effects of financial and power sectors' reforms on the performance of the power sector with the purpose of testing the hypothesis that financial reforms are a condition to the successful implementation of infrastructure reforms.

Appendix

Table A1 - Content of variables and data sources

Variable	Content	Source
privinvt	Natural logarithm of the volume of private investment in energy projects expressed to the GDP deflator.	The World Bank Public-Private Infrastructure Advisory Facility database (year).
gdppc	Natural logarithm of GDP per capita (2000 USD constant).	The World Bank World Development Indicators database.
liqliab	Domestic banks liquid liabilities as a share of GDP: measures the absolute size of the banking sector.	The World Bank Financial Development and Structure database (2007).
smt	Stock market turnover ratio calculated as the ratio of value of shares traded during a period to average market capitalization: measures the efficiency of the stock market.	Idem.
countryrisk	Composite country risk rating reflecting political, financial, and economic risk ranging from 0 to 100 (the higher the rating the lower the risk).	International Country Risk Guide database (year).
exchrisk	Exchange rate risk variable ranging from 0 to 10 (the higher the value, the lower the risk).	Idem.
corruption	Corruption index ranging from 0 to 6 (the higher the score, the less corrupt the economic system).	Idem.
indepreg	Dichotomous variable that takes on the value 1 if there exists an energy regulatory separated from the executive branch of government and 0 otherwise.	Cubbin and Stern (2006), Machungwa (2005), Ministère des Finances et de la Privatisation du Royaume du Maroc (2005), Pineau (2005), RTE (2006), and various websites (see references).
intrate	Real interest rate (%).	The World Bank World Development Indicators database.
tdlosses	Electricity transmission and distribution losses (% of output).	The World Bank World Development Indicators database.

Table A2 - Summary statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
privinvt	382	17.143	2.168	10.181	22.178
privinvtgdp	455	.011	.022	0	.270
gdppc	1005	7.150	1.010	5.176	9.147
findev	626	-5.60e-10	1.072	-1.280	6.509
liqliab	889	.384	.233	.054	1.295
smt	685	.290	.511	.000	5.010
intrate	786	12.245	32.836	-91.724	572.936
tdlosses	949	16.915	8.980	0	68.951
corruption	868	2	.900	0	5
countryrisk	868	65	8.490	33	82
exchrisk	878	8	2.177	0	10
indepreg	1008	.333	.472	0	1

Table A3 - Correlation coefficients*****

Variable	Correlation coefficient
gdppc	0.025
findev	0.402
liqliab	0.320
smt	0.240
intrate	0.191
tdlosses	-0.205
corruption	-0.052
countryrisk	0.320
exchrisk	0.115
indepreg	0.002

*This table gives the correlation coefficients between the variable of primary interest, *privinvt*, and the variables shown in the first column.

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