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# The importance of financial development for infrastructures performance in developing countries - The case of the energy sector

Lika Ndèye Ba

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Doctorat nouveau régime : Sciences économiques

**N. Lika BA**

**The importance of financial development for infrastructures  
performance in developing countries - The case of the energy sector**

**Thèse dirigée par:** Farid GASMI (Professeur, TSE)

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## **Dedication**

*To my beloved family and friends*

## Acknowledgments

*I am particularly indebted to my supervisor, Farid Gasmi, for his constant guidance and unconditional support throughout my thesis. I also thank him for his active commitment to my research project despite the labored context.*

*I will always be grateful to my parents, siblings and close friends for always being by my side and their unconditional love (you rock sweethearts!). I also would like to thank my managers at BNP Paribas, Sébastien Donard and Loan Delaunay, for their understanding and patience all over these years.*

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*Lika*

# Abstract and Keywords

## *Abstract*

The main goal of this dissertation is to highlight the beneficial effects of financial development resulting from financial reforms on performance of infrastructure industries, hence on economic growth, in emerging and developing countries through a set of empirical analyses on the power sector. The first chapter seeks to demonstrate that financial reforms implemented by a host of countries over the past decades have effectively improved financial systems' development using a dataset on 54 emerging and developing countries incorporating newly available dimensions of reforms that have been applied in these countries' financial sector during the mid-1970s through mid-2000s time period. We find a gradual, possibly two-year lagged, but positive and significant global effect of the reforms on the overall level of development of the financial sector.

More importantly, when the impacts of the banking and securities markets reforms on the respective sub-sectors are separately examined, we find that the reforms effectively spur the depth of the banking sector and stock markets' size and liquidity as early as the year of their implementation. Interestingly enough, and consistent with the literature, our findings provide strong evidence that economic development, country risk, and the quality of institutions are key determinants of the financial sector level of development suggesting that these factors do affect the effectiveness of the reforms. In particular, higher economic, financial, and political risk, poorer quality and effectiveness of the legal system, and a more corrupt economic and political system have significant adverse effects on financial development. Regression results also highlight that low fiscal deficit and trade liberalization are beneficial to the financial sector's deepening.

In the second chapter, we assess the extent to which the level of development of a country's financial sector is a factor that draws private participation in infrastructure projects financing. We investigate this issue for the case of the energy sector in a 1990-2007 dataset on 56 developing and emerging countries and find that, unambiguously, a financial sector that offers proper financing solutions and risk-mitigating tools indeed contributes to improving private participation in energy projects. As expected, both economic development and macroeconomic stability are found to be significant determinants of a country's appeal to private investors.

While greater energy needs, as reflected in important network losses, are found to attract private participation, political, economic, and financial risks dampen private investors will to participate in energy projects. A couple of interesting results that come out of the analysis, which

contradict some existing empirical studies, is that higher interest rates and exchange rate risk do not divert away private investors from energy projects. These results can be interpreted as evidence of the positive role played by agreements schemes with governments in building investors' confidence in the developing countries' economic climate.

Putting together results from the two previous chapters, we make the hypothesis of the existence of a significant empirical link between infrastructure and financial sectors reforms the effects of which are reflected in infrastructure sectors growth and performance. In the third chapter, we seek to demonstrate this hypothesis which empirical validity would imply that infrastructure sectors can be expected to benefit from financial reforms in terms of growth and performance. We investigate the impact of four important components of the power sector reforms in developing countries on some of this sector's performance outcomes and assess the contribution of the domestic financial systems. The power sector reform policies examined are the unbundling of generation, transmission, and distribution, the introduction of competition typically coupled with the implementation of privatization programs in the generation and distribution segments, and the creation of an independent energy regulatory authority.

In a dataset on 42 developing countries covering the 1990-2005 period, we find that private participation in generation and distribution has significantly improved power supply and operational efficiency as reflected in higher electricity generation per capita, greater labor productivity, lower distribution losses, and better coverage. The creation of a separate regulatory agency is also found to have enhanced the sector's performance in terms of actual output, labor productivity, and coverage.

Interestingly, we find that the effects of the unbundling of generation, transmission and distribution segments, and the creation and experience of an autonomous regulator have been exacerbated by the modernization of the financial systems. In particular, deeper and more liquid financial markets have eased access to long-term financing for operators allowing them to upgrade their networks and hence to increase output, decrease power losses in distribution, and increase labor productivity and access. Therefore, these empirical results suggest that countries that have implemented reforms that deepen most their domestic financial systems have been able to tap on more benefits from their infrastructure sectors' reforms.

### ***Keywords***

Developing countries, energy sector, financial reforms, power sector reforms, economic and financial development, public-private partnership, panel data

# Résumé et Mots Clés

## *Résumé*

L'objectif de cette étude est de mettre en lumière les effets bénéfiques du développement des systèmes financiers résultant des réformes financières sur la performance des industries d'infrastructures, donc sur la croissance économique, dans les pays émergents et en voie de développement à travers une série d'analyses empiriques sur le secteur de l'énergie. Utilisant un échantillon de 54 pays ainsi que de nouveaux indicateurs des réformes financières implémentées entre le milieu des années 1970s et 2000s, le premier chapitre vise à démontrer que ces mesures ont effectivement amélioré le développement des systèmes financiers de ces pays. Les résultats empiriques montrent un effet positif et significatif, bien que graduel, des réformes financières sur le niveau de développement du secteur financier.

Plus précisément, l'analyse des effets respectifs des réformes bancaires et des marchés des capitaux sur le développement de ces sous-secteurs confirme que ces deux composants des réformes favorisent aussi bien le développement du secteur bancaire que celui des marchés financiers et ce dès l'année de leur mise en place. Il est également intéressant de noter que le niveau de développement économique et de dette publique, les risques politique, économique et financier des pays, leur développement institutionnel ainsi que la libéralisation commerciale sont également des déterminants clés du développement du secteur financier.

Dans le deuxième chapitre, nous évaluons dans quelle mesure le niveau de développement du secteur financier d'un pays peut le rendre plus attractif du point de vue des investisseurs privés pour le financement des projets d'infrastructures. Considérant le secteur de l'énergie de 56 pays émergents et en voie de développement sur la période de 1990 à 2007, nous constatons que les pays attirant le plus de capitaux privés sont ceux dont le secteur financier, à la fois le secteur bancaire et les marchés financiers, est le plus développé. Ce résultat confirme qu'un système financier suffisamment mature pour offrir les services financiers et instruments de couverture de risque appropriés contribue significativement à rendre les pays émergents et en développement plus attractifs pour les investisseurs privés.

Nos résultats montrent également que ces investisseurs prennent en compte le niveau de développement économique des pays, leur stabilité macroéconomique, leur niveau de risques et la qualité des institutions dans leur décision de participer au financement de projets du secteur de l'énergie. Quelque peu en contradiction avec la littérature existante, il semble que des taux d'intérêts ou de risque de change élevés ne poussent pas les investisseurs à se retirer des projets

d'énergie pour des projets plus profitables. Ces résultats pourraient refléter le rôle primordial des gouvernements et organismes de développement dans l'amélioration de la participation des investisseurs privés dans les projets d'infrastructures des pays en voie de développement.

Étant donné les conclusions des deux premiers chapitres, nous faisons l'hypothèse qu'il existe une relation significative entre les réformes des industries des infrastructures et du secteur financier dont les effets se reflètent dans la croissance et la performance des infrastructures. Dans le troisième chapitre, nous cherchons alors à démontrer cette hypothèse dont la validité empirique impliquerait que les réformes des secteurs des infrastructures devraient bénéficier des réformes financières en termes de performance. Dans notre analyse, nous considérons le secteur de l'électricité de 42 pays émergents et en voie de développement de 1990 à 2005. Les réformes sectorielles prises en compte sont la création d'une autorité indépendante de régulation, le dégroupage des segments de génération, de transmission et de distribution, l'introduction de la concurrence et l'implémentation de programmes de privatisation dans les segments de génération et de distribution.

D'après nos résultats, l'implication du secteur privé dans les segments de génération et de distribution améliore l'offre d'électricité et la fiabilité du réseau comme en témoignent l'augmentation de la génération par tête, l'amélioration de la productivité, la baisse des pertes de distribution et une meilleure couverture. La création d'une autorité de régulation indépendante contribue également à l'amélioration de la performance du secteur en termes de production, de fiabilité technique du réseau et de couverture. Par ailleurs, les impacts positifs du dégroupage des segments de génération, de transmission et de distribution, ainsi que de l'existence d'une autorité de régulation sont exacerbés par la modernisation des systèmes financiers.

Plus précisément, nos résultats suggèrent qu'en facilitant l'accès au financement, un secteur financier plus développé permet aux opérateurs de moderniser et améliorer leurs réseaux dans le but d'augmenter leur capacité de génération et leur production, d'améliorer la productivité et réduire les pertes d'énergie dans le segment de la distribution. Ainsi, les pays en voie de développement devraient réformer leurs systèmes financiers domestiques en même temps que leurs secteurs d'infrastructures pour pouvoir bénéficier pleinement des externalités positives que pourrait avoir le secteur financier sur la performance de ces secteurs.

### ***Mots clés***

Pays en développement, secteur de l'énergie, réformes financières, réformes secteur de l'électricité, développement économique et financier, secteurs public et privé, données de panel

# Table of contents

Dedication .....	2
Acknowledgments .....	3
Abstract and Keywords .....	4
Résumé et Mots Clés .....	6
Table of contents .....	8
List of tables .....	9
General introduction .....	10
Chapter 1 .....	15
Have financial reforms improved financial systems' size and liquidity in developing countries? 15	
1.1 Introduction .....	15
1.2 Related literature .....	18
1.3 The data .....	20
1.4 Empirical analysis .....	25
1.4.1 Overall effect of financial reforms on the level of development of the financial sector ..	27
1.4.2 Disentangling the effects of the banking sector and securities markets reforms .....	29
1.5 Conclusion .....	32
Chapter 2 .....	35
The relationship between financial development and private investment in the power sector .....	35
2.1 Introduction .....	35
2.2 Background and review of some related work .....	37
2.3 The Data .....	41
2.4 Empirical analysis .....	47
2.5 Conclusion .....	52
Chapter 3 .....	55
To what extent do infrastructure and financial sectors reforms interplay? - Evidence from panel data on the power sector in developing countries .....	55
3.1 Introduction .....	55
3.2 The performance of the power sector reforms .....	56
3.3 The role of the financial sector reforms: Some testable hypotheses .....	59
3.4 The data .....	62
3.5 Empirical analysis .....	66
3.6 Conclusion .....	74
References .....	77
Appendix 1 .....	86
Appendix 2 .....	91
Appendix 3 .....	93

## List of tables

Table 1.1 - Sample countries.....	20
Table 1.2 - Variables and designation.....	22
Table 1.3 - Financial reforms index .....	26
Table 1.4 - Private capital flows.....	27
Table 1.5 - Banking sector reforms .....	29
Table 1.6 - Stock markets reforms .....	30
Table 2.1 - Countries in the sample.....	42
Table 2.2 - Variables and designation.....	44
Table 2.3 - RE parameter estimates ( <i>findev</i> ).....	49
Table 2.4 - RE parameter estimates ( <i>liqliab</i> and <i>smt</i> ).....	49
Table 3.1 - Testable hypotheses .....	60
Table 3.2 - List of countries in the sample.....	61
Table 3.3 - Variables and designation.....	63
Table 3.4 - Electricity generation per capita ( <i>generationpc</i> ) regression parameter estimates .....	67
Table 3.5 - Electricity sales per employee ( <i>salesperemp</i> ) regression parameter estimates .....	68
Table 3.6 - Transmission and distribution losses ( <i>distlosses</i> ) regression parameter estimates.....	69
Table 3.7 - Electrification ( <i>electrification</i> ) regression parameter estimates .....	70
Table 3.8 - Hypotheses testing .....	72

## General introduction

In past decades, many developing countries experienced relatively high economic growth. These growth prospects, along with rapid urbanization, climate change, and the induced increase in economic activity call for infrastructures modernization and expansion mainly through an increase in investment to improve these sectors' performance. However, while the importance of infrastructures for poverty reduction and long-term economic growth has been highlighted since the 90s, the nature of infrastructures projects themselves makes this task rather difficult (Prud'homme, 2005, Saidi, 2006, Jerome, 2011). Indeed, these projects not only mobilize lumpy investment but they also have longer payoffs delivered in local currency and are exposed to political interference, currency devaluation, and interest rates' volatility. The World Bank (2006) has also emphasized the susceptibility of these projects to the institutional and regulatory framework, corruption and rule of law in particular.

Furthermore, low or non-existent sovereign credit ratings and under-developed financial sectors are among the factors that limit private commitments to infrastructure projects in low income and developing countries. Developing countries' financial markets being often characterized by high volatility, low liquidity coupled with high risk, inadequate regulation and high transaction costs, it is therefore crucial that these countries deepen their domestic financial systems so that they can offer debt and equity denominated in local currency in competitive terms as well as proper financial instruments to mitigate risks inherent to infrastructures projects to help attracting more private capital (Sheppard et al., 2006, Platz, 2009, Calitz and Fourie, 2010). Sustaining good quality of infrastructures service delivery therefore requires an appropriate sequencing of infrastructures, financial and institutional reforms (OECD, 2014).

To bridge the investment and demand-supply gaps they currently face, emerging and developing countries need to enhance public spending in infrastructures as well as attract more private capital. Given the public sector limited resources to ensure financing along with operational activities required to provide quality of service, Public-Private Partnerships (PPPs) have increasingly become one of the most popular mechanisms used to mobilize private capital for infrastructure projects funding. Moreover, many countries undertook structural reforms of their infrastructure and financial sectors in the late 80s early 90s with the main objective of promoting foreign and domestic private investment, and benefiting from the positive impacts of financial systems' development.

Despite these efforts, many developing countries encountered difficulties in implementing

reforms due to institutional weaknesses. Moreover, developing countries' financial systems may have not yet reached the level of development that would significantly catalyze private investment in infrastructure. While the need for emerging and developing countries to boost investment in infrastructure projects has been emphasized by the literature, the issues of these countries' limitations to attract private capital and the combined effect of structural and financial reforms on sectoral performance remain relatively weakly explored.

Although models vary, the existing theoretical and empirical literature on the role of the financial system in economic growth generally highlights that financial development matters for economic growth. See McKinnon, 1973, Shaw, 1973, King and Levine, 1993a, Levine, 1997, Demirgüç-Kunt and Levine, 1996, Spiegel, 2001, Beck and Levine, 2002, Abdurouhman, 2003, Levine, 2004, among others. Indeed, theoretical models suggest that financial intermediaries, markets, and instruments help alleviating market frictions induced by transaction and information costs, including those associated with contract enforcement, exchange of goods and services, and financial claims. Coupled with legal, regulatory, and tax systems, information and transaction costs have encouraged the creation of particular types of financial arrangements. Financial systems may therefore affect economic agents' incentives and constraints, hence saving rates, resources allocation across space and time, technological innovation, and long-term growth (Levine, 2004).

Levine (1997) summarizes the role of the financial system in attenuating information, enforcement, and transaction costs into five basic functions, namely, savings mobilization, provision of ex ante information about investment opportunities and capital allocation, corporate governance, and investment and management monitoring, trading, hedging, and diversification and pooling of risks, and promotion of exchange of goods and services. Hence, financial development occurs when the financial system, i.e., the set of financial instruments, intermediaries, and markets, does a better job at providing these functions (Levine, 2004).

Fitzgerald (2007) argues that the size, efficiency, and composition of a financial system are the three main characteristics expected to gauge the effect of its five basic functions on economic growth. More specifically, savings pooling by financial intermediaries consists of collecting the excess resources of thousands of economic agents and invest them in hundreds of firms. This financial arrangement therefore allows intermediaries to save on the associated information and transaction costs by exploiting economies of scale and overcoming investment indivisibilities. Moreover, financial systems that effectively mobilize savings can significantly impact growth through savings rates, capital accumulation, resources allocation, and technological innovation

(Levine, 2004).

By collecting ex-ante information about potential investment projects, financial intermediaries also reduce information costs for individual savers, which may in turn contribute to greater resources allocation and growth (Greenwood and Jovanic, 1990). Financial intermediaries may also promote technological innovation by selecting the most innovative projects and those with the best chances of success (King and Levine, 1993b). It is also easier for savers to access information about firms when trading in larger and more liquid financial markets, with positive externalities on capital allocation and economic growth (Levine, 2004).

Among market frictions that may impede the proper monitoring of investment projects, information asymmetries between lenders and borrowers, high costs, and the complexity of the monitoring process tend to be the most challenging. Theory suggests that these frictions may be attenuated by financial arrangements with positive effects on growth. Indeed, public trading of shares in liquid stock markets that effectively reveal information about firms enables shareholders to tie managerial compensation to stock prices, thereby aligning managers and shareholders' interests (Diamond and Verrecchia, 1982). Moreover, takeover threats on underperforming firms in these markets may encourage better governance.

Similarly, debt contracts between savers and investors may also help lowering the costs of monitoring firms' insiders (Boyd and Smith, 1994). By assuring delegated projects monitoring for individual savers, financial intermediaries save on aggregate costs, which allow them to efficiently make credit available to firms thereby fostering productivity, capital accumulation, and hence economic growth. Furthermore, this arrangement evicts the free-rider problem and may further lower information costs thanks to the long-term relationship that intermediaries develop with their customers, with positive impacts on growth (Diamond, 1984, Bencivenga and Smith, 1993).

In the presence of information and transaction costs financial systems are also expected to facilitate the trading, hedging, and pooling of risks across individuals, projects, and time with potential positive externalities on resources allocation and growth (Levine, 2004). The intuition is rather straightforward: on the one hand savers usually do not like risk, and on the other hand high-return projects tend to be the riskiest. The availability of risk diversification instruments may therefore allow a portfolio shift toward higher expected returns and innovative projects, and enhance savings rates and capital allocation.

In particular, liquidity risk, which emerges when there are uncertainties about how easily an asset can be changed into a medium of exchange, may be significantly detrimental to growth as

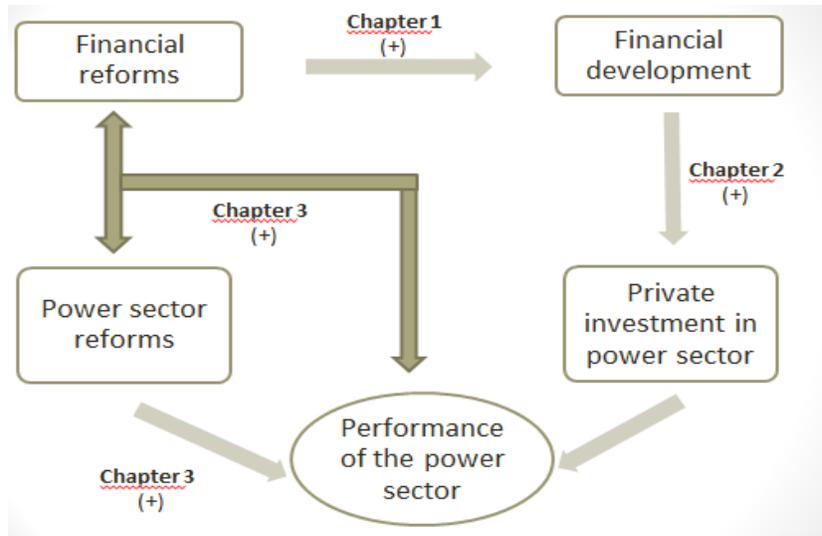
most high-return and growth-promoting projects require long-term financing while savers often do not like to renounce their savings for long periods (Levine, 1997). Liquid financial markets allow savers to easily sell their assets and get their savings back while at the same time transforming these liquid assets into permanent long-term investments for firms. Thus, a decrease in the transaction costs will lead to more investment in the illiquid and higher-return projects, which may foster economic growth. Financial intermediaries may also improve liquidity by offering liquid deposits to savers and undertake a mixture of liquid low-return investments and illiquid high-return investments in parallel.

As projects are subject to shocks, financial intermediaries have the possibility to sell an option associated to a line of credit for renegotiation with firms in certain states of nature, which is likely to have a positive effect on capital allocation efficiency. These results also apply to research and development (innovation) and accumulation of human capital (skills) projects. Finally, specialization being the main factor that enhances productivity while requiring many transactions, financial systems developed enough to lower transaction costs may therefore help promoting specialization with positive impacts on productivity and exchange of goods and services.

Based on the existing theory on the role of financial development in economic growth, the main hypothesis that this dissertation seeks to investigate is that the development of financial systems resulting from financial reforms should have positive externalities on infrastructure sectors' development, hence on economic growth, in particular when the institutional environment is favorable. We explore this hypothesis through a stepwise set of empirical analyses on these countries' power sector and financial systems as depicted in figure 1 below. In the first chapter, we seek to confirm that financial reforms undertaken by a host of countries over the past decades have effectively enhanced the development of their financial systems in a dataset on 54 developing and emerging countries covering the 1973-2005 period.

In the second chapter, using a dataset on 56 developing and emerging countries from 1990 to 2007, we investigate the determinants of private investment in developing countries' energy projects financing with a special focus on the importance of financial development in these countries' attractiveness for private investors. Putting together the findings of chapters one and two we test in the third chapter the hypothesis that financial development resulting from financial reforms strengthens the effects of the power sector reforms on this sector's performance. Indeed, we expect deeper and more liquid financial systems to facilitate access to long-term financing and improve private participation, which are crucial to the performance of the electricity sector.

**Figure 1 - Empirical strategy**



# Chapter 1

## Have financial reforms improved financial systems' size and liquidity in developing countries?

### 1.1 Introduction

The existing literature on the finance-growth relationship emphasizes that financial development matters for economic growth by alleviating market frictions induced by transaction and information costs (see for instance McKinnon, 1973, Shaw, 1973, King and Levine, 1993a, Levine, 1997). By attenuating these market frictions, financial systems fulfill the primary function of paving the road to an efficient resource allocation across space and time in uncertain environments.

Levine (1997) breaks this primary function into five basic components, namely, savings mobilization (1), capital allocation (2), corporate governance and management monitoring (3), trading, hedging, and diversification and pooling of risks (4), and promotion of exchange of goods and services (5). Financial development therefore occurs when the financial system is more efficient in providing its five functions (Levine, 2004). Similarly, Huang (2006) defines financial development as the capacity of a financial system to enhance the efficiency of financial resources' allocation and to monitor capital projects through improved competition and financial depth. Financial development is hence a matter of structure, size, and efficiency of a financial system.

It is commonly asserted that financial development may be fostered by financial reforms and through several mechanisms. First, reforms may alleviate financial repression in protected financial markets, thereby allowing real interest rates to reach their competitive market equilibrium level. Second, the removal of capital controls allows domestic and foreign investors to hold more diversified portfolios, which in turn may decrease the cost of capital. Third, financial liberalization leads to more integrated markets, which also helps reducing the cost of capital. Fourth, reforms of the financial infrastructure may lessen information asymmetry, thus reduce adverse selection and moral hazard effects, and increase funds availability. Last, but not least, the liberalization process often contributes to improving the financial system's efficiency by removing inefficient financial institutions (Ito, 2005).

In an effort to spur the development of their financial systems, a great number of developing countries implemented structural reforms of their financial sectors in the 1980s and the 1990s. Although their extent and pace vary across regions, these reforms often include the opening of financial markets, thus giving foreign investors the opportunity to invest in domestic equity securities and increasing domestic and foreign competition, the lessening of public interferences, and the removal of restrictions on financial activities, in particular, through the removal of interest rates and credit controls, the privatization of commercial banks coupled with the strengthening of the independence of central banks, and the introduction of financial regulation and supervision.<sup>1</sup>

However, the financial crisis episodes in Asia (1997), Mexico (1994), and Russia (1998), as well as the more recent global financial crisis of 2007-2008, have raised a new debate on the costs and benefits of financial liberalization. Some economists have warned on the need for developing countries to put some limits on capital inflows to alleviate excessive shifts in financial markets (Stiglitz, 2000, Bekaert et al., 2005, Kaminsky and Schmukler, 2002). Some authors have even argued that the effects of these crises were amplified by financial liberalization (Ang and McKibbin, 2007, Tswamuno et al., 2007).

Despite the potential adverse effects of capital account liberalization, policy makers do not seem to have given up the path of financial reforms. In the contrary, they pay a great attention to the link between economic development and financial integration, focusing on the importance of financial liberalization sequencing and its effects on financial development, economic growth and stability, and on the importance of the institutional environment, in particular, better supervision and regulation of the financial sector.

Most empirical studies of the finance-growth relationship have reported a positive impact of financial development on economic growth (Levine, 1997, Beck and Levine, 2002, Spiegel, 2001, Abdurouhman, 2003). However, the studies of the effects of financial reforms on financial development have essentially focused on the impact of capital account opening on the level of development of the banking sector, hence leaving out stock markets and other important aspects of the reforms.<sup>2</sup> This chapter attempts to contribute to filling this void by incorporating a larger set of reform measures that have been implemented and by distinguishing the banking sub-sector and the capital markets in the investigation of the effects of financial reforms on the development

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<sup>1</sup> In many developing countries, the banking sub-sector represents the largest share of the financial sector. Consequently, one should expect the implemented reforms to have a more perceptible effect on this sub-sector than on the yet emerging securities markets.

of emerging and developing countries' financial sector.

Fixed-country effects regression models are fitted to a 1973-2005 annual dataset on 54 emerging and developing countries. Financial development indices are constructed from variables that capture the size and the degree of liquidity of the banking sector and stock markets. Moreover, reforms indicators considered in our empirical analysis seize various dimensions of the implemented policies, in particular, the degree of openness of the financial sector to domestic and international financial institutions and investors, the degree of competition introduced in the sector, the level of privatization, and the extent of regulation. In line with the existing literature, the level of country risk and factors describing the institutional environment are also accounted for.

Our analysis of the overall effects of the reforms undertaken by emerging and developing countries on these countries' financial sector shows that, although a two-year adjustment period has been sometimes required, the reforms have significantly improved the development of the financial systems. When examining separately the effects of banking and securities markets reforms, we find that they have effectively spurred the development of respectively the banking sector and stock markets as early as the year of their implementation. Interestingly, our findings also highlight that country risk and the quality of institutions are factors that affect significantly financial development, and hence have a role to play in the reforms effectiveness. We also find evidence that economic development and trade liberalization contribute to financial deepening while political regime change does not seem to be beneficial.

This chapter is organized as follows. The next section provides a review of the literature that discusses the importance of financial reforms for the development of the financial sector and economic growth. Section 3 describes the data used and briefly discusses the main properties of the variables of interest. Section 4 presents the econometric analysis and the results obtained. Section 5 concludes and Appendix 1 gives further details on the data and some summary statistics.

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<sup>2</sup> In the remainder of the paper, the implemented financial reform policies are referred to as "the reforms."

## 1.2 Related literature

The actual relationship between financial reforms, financial development and economic growth is of great importance to developing and emerging countries' policymakers. Indeed, convincing evidence that the financial system's development has positive effects on long-term growth will induce further research on the political, legal, regulatory and policy determinants of financial development and influence the priority attached to reforming the financial sector. Moreover, it would allow countries to stimulate their economic development by exploiting benefits from financial reforms (Levine, 2004).

Levine (2001) examines whether international financial liberalization can foster economic growth by enhancing the functioning of domestic financial markets and banks. Focusing on the long-term effects of international financial integration, he finds that the latter can positively affect economic growth through mechanisms not often highlighted by the existing literature. First, the presence of foreign banks tends to boost the domestic banking system's efficiency, thereby stimulating productivity and growth. Second, lifting restrictions on international portfolio flows spurs the domestic stock market's liquidity, which also fosters productivity and growth.

Ang and McKibbin (2007) study the finance-growth relationship in Malaysia through cointegration and various causality tests, using time series data from 1960 to 2001, and accounting for saving, investment, trade and real interest rate. Unlike Levine (2001), their empirical results show that even if financial liberalization has enlarged the financial system, it has not resulted in higher long-run growth. On the contrary, output growth appears to have a positive causal effect on financial depth in the long-run.

Similarly, Tswamuno et al. (2007) analyze the effects of financial liberalization in South Africa using data from 1975Q3 to 2005Q1 and find that increased stock market liquidity and non-resident participation after liberalization did not foster economic growth. Moreover, increased integration has had a negative effect on economic growth. These findings suggest that financial liberalization may have adverse effects on economic growth if no appropriate foundations are set to stabilize the real economy.

The existing literature focusing on the effects of financial reforms on financial development, which is the subject of this study, has led to results varying across countries and methodologies. Claessens et al. (1998) investigate the effects of capital account opening on the domestic banking system using bank-level data on 80 countries covering the period 1988-1995. They find that opening banking markets and the increase in the number of foreign entrants, rather than their market share, enhance domestic banking systems' efficiency with reduced profitability

and expenses in domestically owned banks.

Huang (2006) studies the relationship between financial openness and financial depth in 35 emerging markets from 1976 to 2003, with measures of financial openness and financial development comprising variables from the banking sector, stock markets and national capital accounts. His findings indicate that financial openness is a key determinant of the level of financial development. When testing this effect on the development of the banking sector and that of stock markets separately, a strong and robust link is found for stock markets only. For the case of Chile, De Gregorio (1999) also finds that higher financial integration leads to a deeper financial sector.

Likewise, Klein and Olivei (1999) analyze the effects of capital account opening on both financial depth and economic growth for developed and developing countries from 1976 to 1995 and from 1986 to 1995 respectively. Their results from cross-section analysis show that countries that opened their capital accounts exhibit significantly greater increase in financial depth than countries that maintained capital account restrictions and these findings hold in particular for developed countries. In contrast, capital account liberalization failed to foster financial depth in developing countries, suggesting that economic, legal, and institutional reforms are needed in these countries for capital account liberalization to stimulate financial development.

Some authors indeed paid a particular attention to the importance of accounting for the level of legal and institutional development when investigating the impacts of financial reforms on financial development. Ito (2005) examines whether financial openness led to financial systems' deepening in Asia from 1980 to 2000, while controlling for countries' legal and institutional development. His findings show evidence that a greater level of financial openness fosters equity market development only if a certain level of legal development has been reached.

Similarly, Chinn and Ito (2006) emphasize that a threshold of legal and institutional development has to be achieved for financial liberalization to contribute to equity markets' development, in particular in emerging market countries. More precisely, a higher level of bureaucratic quality and law and order as well as low corruption may significantly improve the effect of financial liberalization in boosting equity markets' development.

Using an error-correction panel model with non-overlapping data for ten South Mediterranean Sea (SMS) countries from 1980 to 2005, Beji (2007) also tests the impact of legal and institutional development on the effects of financial liberalization on financial development. The author reaches the same conclusion as Chinn and Ito (2006), that is to say that countries should first improve their legal and institutional environment to benefit from the positive effects

of financial liberalization.

Tressel and Detragiache (2008) study the effects of banking sector reforms on the level of development of the financial sector of 85 countries over 1973-2005 using a newly available database on implemented reforms. They find that financial reforms indeed improve the banking sector's development but only in countries with well-developed political institutions. For the case of Mediterranean countries from 1985 to 2009, Ayadi et al. (2013) find that strong legal institutions, good democratic governance, and the proper implementation of financial reforms may have a significant positive effect on financial development, provided that they are jointly present.

This chapter seeks to contribute to the existing literature by empirically examining how the various dimensions of financial reforms affect the sector's level of development, considering both the banking sector and stock markets, and accounting for country risk and institutional environment.

### 1.3 The data

To investigate the effects of financial reforms on the financial sector's development, we collected data on 54 emerging and developing countries in Latin America and the Caribbean (LAC), Asia, Middle East and North Africa (MENA), and Sub-Saharan Africa (SSA) as shown in Table 1.1 below. This table also gives the World Bank income group each of these countries belongs to.<sup>3</sup> The study covers the period from 1973 to 2005 as dictated by data availability but also to include pre and post reforms periods. Moreover, not all the data were available for all the years and countries, leading to an unbalanced panel and a number of observations varying across models.

Table 1.2 exhibits the list of variables on which data have been collected.<sup>4</sup> The financial development index *findev*, the main dependent variable in this study, seizes the level of development of countries' overall financial sector and is calculated as the first principal component of variables that represent the development of the banking sector and stock markets. The depth of the banking sector is captured by the variable of domestic banks liquid assets as a fraction of GDP denoted *bsdev*. For stock markets we use the variables *smc* and *tvf* which are also expressed as ratios to GDP and represent, respectively, stock market capitalization and the value

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<sup>3</sup> 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.

<sup>4</sup> More detailed information on the data, summary statistics and correlation coefficients are given respectively in

of shares traded. These variables are meant to measure the size of the capital market and its liquidity respectively and we denote *smdev* their first principal component.

The main independent variables of interest are grouped under the label "Financial reforms". Overall financial reforms are measured by the global index *finreforms* from Abiad et al. (2008). This index seizes seven features of financial reforms, namely credit controls and reserves requirement, interest rate control, entry barriers into the banking sector (competition), the extent of privatization of domestic banks, the banking sector's supervision (regulation), capital account liberalization, and policies undertaken to restrict or stimulate the development of bond and stock markets. The latter dimension of reforms comprises measures such as the possibility of auctioning government securities, the establishment of debt and equity markets, and the implementation of measures to encourage the development of these markets such as tax incentives or the development of depository and settlement systems, and policies promoting (or restricting) the openness of securities markets to foreign investors.

We denote *bsreforms* the banking sector reforms index calculated as the sum of policies targeting the banking sector while *smreforms* refers to implemented policies affecting stock markets. The higher these variables' score, the less repressed the financial sector. For robustness checks, we also consider another indicator of reforms that is not based on a scoring system, namely controls on private capital flows (*privcap*) into a given country. Expressed as a ratio of GDP, this variable captures the extent of financial liberalization and is equal to the sum of net foreign direct investment, net portfolio investment and other investments in the balance of payments. The main conjecture of this chapter is that implemented financial reforms as measured by variables *finreforms*, *bsreforms*, *smreforms*, and *privcap* are key determinants of the development of sample countries' financial sector.

**Table 1.1 - Sample countries\***

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
Azerbaijan	Europe & Central Asia	Lower middle income
Bangladesh	South Asia	Low income
Belarus	Europe & Central Asia	Upper middle income
Bolivia	Latin America & Caribbean	Lower middle income
Brazil	Latin America & Caribbean	Upper middle income
Burkina-Faso	Sub-Saharan Africa	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
Ethiopia	Sub-Saharan Africa	Low income
Ghana	Sub-Saharan Africa	Low 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
Jordan	Middle East & North Africa	Lower middle income
Kazakhstan	Middle East & North Africa	Lower middle income
Kenya	Sub-Saharan Africa	Low income
Kyrgyz Rep	Europe & Central Asia	Low income
Latvia	Europe & Central Asia	Upper middle income
Lithuania	Europe & Central Asia	Upper middle income
Madagascar	Sub-Saharan Africa	Low income
Malaysia	East Asia and Pacific	Upper middle income
Mexico	Latin America & Caribbean	Upper middle income
Morocco	Middle East & North Africa	Lower middle income
Mozambique	Sub-Saharan Africa	Low income
Nepal	South Asia	Low income
Nicaragua	Latin America & Caribbean	Lower middle income
Nigeria	Sub-Saharan Africa	Low income
Pakistan	South Asia	Low income
Paraguay	Latin America & Caribbean	Lower 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
Uruguay	Latin America & Caribbean	Upper middle income
Venezuela	Latin America & Caribbean	Upper middle income
Zimbabwe	Sub-Saharan Africa	Low income

\* For the following countries, data on stock markets were not available: Albania, Algeria, Azerbaijan, Belarus, Burkina Faso, Cameroon, Dominican Republic, Ethiopia, Madagascar, Mozambique, Nicaragua, and Senegal.

In addition to these variables, we use some indicators of countries' level of risk and institutional development listed under the label "Institutional and risk variables". These indicators are meant to represent the country's level of economic, financial and political risk (*countryrisk*), the extent of the legal system's impartiality and the observance of the law (*laworder*), the degree of corruption of a country's economic and political system (*corruption*), and the quality of its bureaucracy (*burqual*). Indeed, high political, financial, and economic risks are factors that may discourage investment, hence dampen financial development. In contrast, better legal system and bureaucratic quality may help reduce business uncertainty and attract more investors, thereby fostering financial deepening.

The effect of corruption is more difficult to predict. While it is one of the most important factors that may prevent middle to long-term foreign investment in developing countries, thereby worsening financial development, not entering a market is not always an attractive option for multinational investors which may bribe countries' local officials to further protect their investment (MIGA, 2012, Banerjee et al., 2006). As more developed countries are expected to have more developed financial systems we control for economic development by means of the natural logarithm of GDP per capita (*gdppc*). The set of independent variables also comprises countries' inflation rate (*inflation*) that may jeopardize financial depth by amplifying market imperfections through lower real returns (Boyd et al., 2001, Ayadi et al., 2013).

As heavily indebted countries are likely to rely on the financial sector as a source of funding, hence potentially crowd-out private investment and lead to less efficient financial systems (Ayadi et al., 2013) we include the variable of fiscal balance (*fiscalbal*) in the set of explanatory variables. Following the literature, three other control variables are included in our empirical analysis for robustness checks, namely trade openness (*tradeopen*), creditor rights protection (*cr*), and regime change (*democ*). The variable of trade liberalization is given by exports minus imports as a percentage of GDP and is expected to have a positive side effect on financial development (Do and Levchenko, 2004, Huang and Temple, 2005).

The creditor rights index is constructed by Djankov et al. (2007) who argue that it may impact financial development, especially the banking sector's, through the legal and information sharing systems. Finally, the variable *democ* is meant to capture regime change from autocracy to democracy in sample countries. The existing empirical literature suggests that democracy may foster financial development mainly through stable politics, improved fundamental civil liberties, property rights protection and contract enforcement but also by discouraging corruption and

lawlessness. However, under the pressure from various interest groups, democracy may also lead to economic disorder due to inefficiencies in decision-making and difficulties in implementing sound policies, political instability, and ethnic conflict (Huang, 2010).

**Table 1.2 - Variables and designation**

Variable	Designation
Financial development	
<i>findev</i>	Domestic overall financial sector development variable
<i>bsdev</i>	Domestic banking sector development variable
<i>smdev</i>	Domestic stock markets development variable
Financial reforms	
<i>finreforms</i>	Global financial reforms index
<i>bsreforms</i>	Banking sector reforms index
<i>smreforms</i>	Securities markets reforms index
<i>privcap</i>	Financial liberalization indicator (%)
Institutional and risk variables	
<i>countryrisk</i>	Country risk index (the higher the rating the lower the risk)
<i>laworder</i>	Law and order variable (the higher the rating the better the legal system)
<i>corruption</i>	Corruption index (the higher the score the less corrupt the economic system)
<i>burqual</i>	Bureaucratic quality index (the higher the rating the better the quality)
Control variables	
<i>gdppc</i>	GDP per capita
<i>inflation</i>	Inflation rate (%)
<i>fiscalbal</i>	Fiscal balance (%)
<i>tradeopen</i>	Trade liberalization indicator (%)
<i>cr</i>	Creditor rights index (the higher the score the stronger creditors' rights)
<i>democ</i>	Regime change index (the higher the score the more democratic the regime)

In a preliminary analysis, we examine the relationship between the main variables of interest by means of causality tests. More specifically, we ask whether there exists a causal relationship between the variables that measure the level of development of countries' financial

sector, *findev*, *bsdev* and *smdev*, on one hand, and the variables which proxy financial reforms, namely *finreforms*, *privcap*, *bsreforms*, and *smreforms*, on the other hand. To this end, we apply a standard Granger-type causality testing procedure suited for panel datasets.<sup>5</sup> 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 causality relationship that runs from reforms indicators to the financial development variables, thereby suggesting that the former variables may be included as predictors of financial development in the econometric regression analysis to which we now turn.<sup>6</sup>

## 1.4 Empirical analysis

Have financial reforms implemented by developing countries led to deeper financial systems as intended? To answer this question, we run a series of single-equation regressions for each of the financial development indicators with contemporaneous financial reforms variables and up to their second lag as the main explanatory variables to capture both the "instantaneous" and potentially gradual effects of reforms on financial development.<sup>7</sup> The set of right-hand variables of these regressions also comprises variables that capture some important features of countries' institutional and risk environment. These regression models therefore allow us to empirically test the hypothesis that financial reforms are key determinants of the development of sample countries' financial sectors while controlling for these other features of a country's economy.

Given that our data are in a pooled time-series cross-sectional form, it seemed natural to us to consider fixed- and random-effects (FE and RE) models and discriminate between these two specifications by means of a Hausman test. We finally chose FE models that control for country-specific unobserved effects for three reasons.<sup>8</sup> First, the RE model assumes that the regressors are not correlated with the unobserved country effects. However, factors such as those related to the quality of governance and institutions are very likely to affect financial reforms and hence, when omitted, their impacts are included in the unobserved country-specific term leading to a

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<sup>5</sup> See Hurlin and Dumitrescu (2012).

<sup>6</sup> Surprisingly, we find no causality from banking sector reforms to the sub-sector's development index *bsdev*. The Stata code used to perform these causality tests is the one contained in the working version of Zemčík (2011).

<sup>7</sup> The maximum number of lags of reforms measures included in models was dictated by data availability.

<sup>8</sup> This choice made, we nevertheless realize that, even if the FE estimator is always consistent, the RE estimator, where applicable, is more efficient (Sen and Jasmab, 2010).

correlation between this term and the regressors. Second, the countries included in the sample analyzed are clearly not drawn randomly but are emerging and developing countries for which relevant data were available. Finally, we have performed Fisher test that confirmed the presence of country fixed effects in all the specified models.<sup>9</sup>

We investigate the effects of undertaken reforms on financial development through a stepwise procedure with two main objectives. Our first objective is to analyze the overall effect of financial reforms undertaken by developing countries on the development of their financial sector. A second objective is to further investigate this effect, when it is significant, by decomposing the index *finreforms* into its banking sector and securities markets' reforms parts. We will pay a particular attention to the impacts of each reforms component on the targeted sub-sector's development.

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

$$findev_{it} = \alpha_0 + \mu_i + \sum_{j=0}^2 \beta_j reforms_{it-j} + \sum_{k=1}^{10} \gamma_k X_{it}^k + \varepsilon_{it} \quad (1.1)$$

where  $i = 1, \dots, 54$  and  $t = 1, \dots, 33$  are indices that refer to the country and the year respectively; the variable *findev* stands for the overall financial development measure described in section 3;  $\alpha_0$  is a constant; the variable *reforms* corresponds to one of the financial reforms indicators *finreforms* and *privcap* and the  $\beta_{j,s}$  are the associated coefficients;  $X^k$ s are the control variables that are shown in Table 1.2 under the labels "Institutional and risk variables" and "Control variables", and  $\gamma$  is the vector of coefficients associated with these variables;  $\mu_i$  is a time-invariant country-specific term; and  $\varepsilon$  is the error term.

To achieve the second objective, we disentangle the global financial reforms index *finreforms* into its banking and securities market components to examine their effects on each financial sub-sector, yielding the following general equation:

$$dev_{it} = \alpha_0 + u_i + \sum_{j=0}^2 \beta_j bsreforms_{it-j} + \sum_{j=0}^2 \varphi_j smreforms_{it-j} + \sum_{k=1}^{10} \gamma_k X_{it}^k + \eta_{it} \quad (1.2)$$

where *dev* stands for *bsdev* or *smdev*, and *bsreforms* and *smreforms* are as defined in section 3 above;  $u_i$  is a time-invariant country-specific term; and  $\eta$  is the error term.

As financial reform components may influence each other and can also be determined by financial development, we tested independent variables' potential endogeneity in each model by

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<sup>9</sup> The results of the Fisher test of the presence of country fixed effects are available from the authors upon request.

means of a Durbin-Wu-Hausman test and used their lags as instruments when relevant. At each step described by equations (1.1) and (1.2) we first estimate a "baseline model" comprising institutional and risk variables, GDP per capita, inflation rate, and fiscal balance as control variables.

We then perform some robustness checks by adding trade openness, creditors' rights and democracy indicators one at a time and report the best estimation results based on goodness-of-fit. Part from parameter estimates and their robust standard errors, the tables also present the number of observations actually used to estimate each model, Fisher statistic testing the joint significance of the independent variables or models' goodness of fit,  $F(.,.)$ , and the adjusted  $R^2$  of the model.<sup>10</sup>

#### ***1.4.1 Overall effect of financial reforms on the level of development of the financial sector***

In the analysis which results are presented in this section, we investigate the global effects of financial reforms on the sector's development index *findev* using two measures of reforms, namely the financial reforms index constructed by Abiad et al. (2008), *finreforms*, and the volume of private capital flows as a share of GDP, *privcap*, as described by equation (1.1). Tables 1.3 and 1.4 present estimation results.

The results displayed in Table 1.3 below show that *finreforms* and its first lag are associated to insignificant coefficients while its second lag has a positive and significant effect on the financial development index. It therefore seems that a two-year adjustment period is required for implemented reforms to have the expected positive impact on the depth and liquidity of the financial sector. More importantly, these results support our assertion that the alleviation of financial repression coupled with the introduction of competition and privatization, as well as capital account liberalization have indeed reached some success in fostering the overall financial system's development (Claessens et al., 1998, Huang, 2006). As expected, our findings also highlight that more developed and less indebted countries, as reflected in their high GDP per capita and fiscal balance, have the most developed financial sector. Economic development is therefore beneficial to the development of the financial sector while debt is not.

In contrast, although positive, the effect of inflation on the financial development index is not statistically significant. As to institutional and risk variables, estimation results suggest that it

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We also tested and failed not rejecting the presence of time effects.

<sup>10</sup> We indicate by \*, \*\*, \*\*\* significance at 10%, 5% and 1% respectively. For a given variable  $y$ , we denote  $ly$  its first lag and  $l_2y$  its second lag. Not-reported results are available from the authors upon request.

is countries' legal system that matters the most for financial development. Indeed, the positive and significant effect of the variable *laworder* on the index *findev* implies that a better legal system facilitates the proper implementation of reforms, contracts' enforcement in particular, thereby improving the development of the financial sector (Chinn and Ito, 2005). Following the literature, we also account for countries' openness to trade, creditors' rights protection policy and regime change (Do and Levchenko, 2004, Djankov et al., 2007, Huang, 2010). While the effects of financial reforms and control variables remain mostly unchanged, our findings do not provide evidence that any of these variables has a significant impact on financial development.

**Table 1.3 - Financial reforms index**

Variable	Coefficients	Standard errors
<i>const</i>	-11.53**	4.86
<i>finreforms</i>	-0.01	0.05
<i>lfinreforms</i>	-0.02	0.06
<i>l<sub>2</sub>finreforms</i>	0.08**	0.04
<i>countryrisk</i>	0.02	0.02
<i>corruption</i>	-0.12	0.08
<i>laworder</i>	0.22**	0.11
<i>burqual</i>	-0.12	0.15
<i>gdppc</i>	1.72*	0.90
<i>inflation</i>	0.00	0.00
<i>fiscalbal</i>	0.08*	0.05
Obs.		273
Fisher	F(41, 231) = 25.16***	
$\bar{R}^2$		0.78

Let us now examine how developing countries' financial sector is affected by the extent of financial liberalization captured by the removal of controls on private capital flows. As can be seen from Table 1.4, the higher the volume of private capital flows to a given country the more developed its financial system. In line with Klein and Olivei (1999), our results emphasize that the financial sector is rather responsive to financial liberalization, hence more competition. It is also worth noting that this positive impact is observed within the year of markets' opening while it is not significant the following years, hinting that the benefits from capital opening are rather "instantaneous".

As in the previous analysis, we find that economic development, healthy fiscal accounts as well as a well-functioning legal system are beneficial to financial development as shown by their positive and significant coefficients. These results therefore ask for efforts from developing countries to reduce their debt and improve the effectiveness of their legal system to tap on more benefits from implemented reforms. Unlike Huang 2010, our findings suggest that

institutionalized democracy has an adverse effect on financial development, implying that regime change is not necessarily favorable to financial development. This result may reflect the potential difficulties faced by developing countries' governments in implementing sound policies and the political instability resulting from "premature" democracy.

**Table 1.4 - Private capital flows**

Variable	Coefficients	Standard errors
<i>const</i>	-16.48**	4.63
<i>privcap</i>	11.14*	6.37
<i>lprivcap</i>	1.24	1.71
<i>l<sub>2</sub>privcap</i>	2.22	2.26
<i>countryrisk</i>	-0.02	0.02
<i>corruption</i>	-0.11	0.07
<i>laworder</i>	0.26*	0.14
<i>burqual</i>	0.03	0.15
<i>gdppc</i>	2.70***	0.88
<i>inflation</i>	-0.00	0.00
<i>fiscalbal</i>	0.08*	0.04
<i>democ</i>	-0.01**	0.00
Obs.		229
Fisher		F(38, 190) = 63.47
$\bar{R}^2$		0.81

#### 1.4.2 Disentangling the effects of the banking sector and securities markets reforms

Our findings so far provide us evidence that financial reforms effectively contribute to enhancing the overall financial sector's development, thereby confirming our main conjecture. We now move on to investigating whether the global positive effect of reforms highlighted by our previous analyses can be attributed to a particular dimension of undertaken reforms (equation (1.2)). To this end, we decompose the index *finreforms* into its banking sector and securities markets reforms components denoted *bsreforms* and *smreforms* respectively.

For each sub-sector's development index, *bsdev* and *smdev*, we follow the same steps as in the previous section. First, we consider the baseline model comprising institutional and risk variables, countries' economic development variable, inflation rate, and fiscal balance as control variables. Second, as the literature suggests that they may be important determinants of financial development, we also examine the impacts of countries' openness to trade, creditors' rights' protection policy, or regime change. Tables 1.5 and 1.6 report estimation results for the banking sector (*bsdev*) and stock markets (*smdev*) respectively.

Focusing on the impacts of the banking sector reforms (*bsreforms*) while controlling for securities markets policies (*smreforms*), estimation results reported in Table 1.5 provide strong

evidence that implemented reforms promote the banking sector's development as early as the year of their implementation (Claessens et al., 1998, Tressel and Detragiache, 2008). Our findings therefore imply that implemented banking reforms, namely the removal of credit and interest rates controls, the easing of entry barriers into the sector to promote competition, the introduction of regulation as well as capital account liberalization, significantly improved banks' lending capacity, thereby fostering developing countries' domestic banking sector's depth.

Somewhat surprisingly, we find that the higher a country's current inflation rate the more developed its banking sector. It therefore seems that, while lower current real returns boost credit demand, they push domestic banks into improving their cost efficiency to compensate for these lower returns when inflation is high. Likewise, our estimation results suggest that public debt, as reflected in low fiscal balance, has a crowding-out effect on private debt measured by domestic banks liquid liabilities (Ayadi et al., 2013). In contrast, although positive, the effect of GDP per capita is not statistically significant, suggesting that this indicator is a less important signal to the banking sector's participants than implemented reforms and countries' national account balance.

In line with the literature, regression estimations also highlight that country risk and institutional development significantly affect the banking sector's development. Indeed, we find that high economic, political and financial risk worsens the banking sector's depth as it leads to an uncertain investment environment. Furthermore, the less corrupt a country's economic and political system the more developed its banking sector, hinting that corruption tends to discourage investment hence dampen the sector's depth as reflected in lower banks' private credit capacity (Chinn and Ito, 2006). Our results also indicate that trade liberalization has a positive side effect on the banking sector's development as suggested by the literature whereas the effects of creditors' rights protection and regime change are not statistically significant (Huang and Temple, 2005).

**Table 1.5 - Banking sector reforms**

Variable	Coefficients	Standard errors
<i>const</i>	-0.19	0.42
<i>bsreforms</i>	0.01***	0.00
<i>lbsreforms</i>	0.00	0.00
<i>l<sub>2</sub>bsreforms</i>	0.01	0.00
<i>smreforms</i>	0.01	0.02
<i>lsmreforms</i>	-0.01	0.03
<i>l<sub>2</sub>smreforms</i>	0.03	0.02
<i>gdppc</i>	0.004	0.07
<i>inflation</i>	0.001**	0.00
<i>fiscalbal</i>	-0.01***	0.00
<i>countryrisk</i>	0.002*	0.00
<i>corruption</i>	0.02*	0.01
<i>laworder</i>	0.00	0.01
<i>burqual</i>	0.01	0.02
<i>tradeopen</i>	0.20***	0.06
Obs.		230
Fisher		F(52, 177) = 157.15***
$\bar{R}^2$		0.9726

Turning to investigating whether securities markets reforms have the expected positive effect on stock markets' development, regression results presented in Table 1.6 confirm that implemented policies significantly improve the sector's size and liquidity. More importantly, this positive effect is observed as early as within the year these reforms are put in place and the following year, which suggests a gradual impact of reforms on securities markets. Our findings therefore provide strong evidence that policies undertaken to stimulate the development of bond and stock markets effectively led to deeper and more liquid markets, mainly by fostering capital flows, reducing the cost of capital, and allowing investors to hold more diversified portfolios and benefit from more risk-hedging instruments (Ito, 2005).

Confirming our intuition and in line with results for the overall financial sector (Tables 1.3 and 1.4), we find that the less indebted a country the more developed its stock market. Hence, developing countries' national account balance is a good signal for investors willing to enter their stock markets. As for the banking sector (Table 1.5), estimation results also emphasize that high current inflation tends to boost securities markets' development. This finding suggests that the average market participant rather relies on medium to long-term investment to avoid short-term low real returns.

Surprisingly, creditors' rights protection has an adverse on financial development while it would be expected to reassure and help attract investors by reducing business uncertainty, thereby leading to deeper financial markets. A possible interpretation of this result is that, in

addition to available risk-hedging instruments, likely market participants of developing countries' financial sector rely on guarantees from governments to secure their investment. As to institutional and risk factors, although their associated coefficients are not statistically significant, parameter estimates confirm that they tend to alter stock markets' development.

**Table 1.6 - Stock markets reforms**

Variable	Coefficients	Standard errors
<i>const</i>	-3.65	8.66
<i>smreforms</i>	0.29*	0.17
<i>lsmreforms</i>	0.49**	0.24
<i>l<sub>2</sub>smreforms</i>	0.03	0.16
<i>bsreforms</i>	-0.11	0.07
<i>lbsreforms</i>	-0.04	0.07
<i>l<sub>2</sub>bsreforms</i>	0.07	0.05
<i>gdppc</i>	0.67	1.57
<i>inflation</i>	0.0001*	0.00
<i>fiscalbal</i>	0.21***	0.06
<i>countryrisk</i>	0.008	0.01
<i>corruption</i>	0.11	0.13
<i>laworder</i>	0.03	0.12
<i>burqual</i>	-0.08	0.12
<i>cr</i>	-0.90***	0.33
Obs.		208
Fisher		F(45, 162) = 13.86***
$\bar{R}^2$		0.7366

## 1.5 Conclusion

This chapter empirically investigates the effectiveness of implemented financial reforms in enhancing financial systems' development, accounting for some institutional and risk factors that may affect the financial sector's functioning. Our dataset consists in a time-series-cross-sectional database on 54 developing countries from 1973 to 2005 including recent financial reform indicators constructed by Abiad et al. (2008) that we use to specify fixed-country effects regression models.

Our analysis of the global effects of financial reforms on the overall sector's development highlights that, although their effects are gradual and a two-year adjustment period may be required, the former significantly improves financial development. More specifically, we find that financial liberalization contributes to financial deepening as early as the year of this policy's implementation. Furthermore, consistent with the literature, our regression results emphasize that economic and institutional development are also key determinants of financial development and may therefore affect the impact of reforms. In particular, we find that a poor quality and

effectiveness of countries' legal system may significantly dampen financial development. Similarly, the lower a country's fiscal deficit the deeper its financial sector (Chinn and Ito, 2006, Beji, 2007, Tressel and Detragiache, 2008).

When further investigating the impacts of the banking sector reforms, our findings emphasize that they significantly enhance the sector's development within the year of their implementation. We also find evidence that the depth of the banking sector is influenced by country risk and institutions development. Indeed, high economic, financial and political risks as well as high corruption significantly worsen domestic banks' lending capacity. Moreover, consistent with the literature, our results suggest that trade liberalization has a positive side effect on the banking sector (Do and Levchenko, 2004; Huang and Temple, 2005).

The analysis of the effects of securities markets' policies on stock markets' development also confirms that the implemented measures reached some success in fostering financial markets' development, especially the year these reforms are put in place and the following one. However, we found no evidence of a significant effect of country risk and institutional development on this sub-sector, which suggests that investors likely to enter developing countries' financial markets rather rely on available risk-hedging instruments to secure their investment.

Therefore, as Huang (2006), Gregorio (1999) and Klein and Olivei (1999) among other studies, our empirical results provide evidence of the existence of a positive relationship between financial reforms and the development of both the banking sector and stock markets. More precisely, the easing of controls on credit, interest rates and international financial transactions as well as the alleviation of restrictions on the entry of foreign investors and financial institutions into the domestic market, the degree of privatization and regulation of the domestic banking sector are all important drivers of the development of a country's financial sector.

Indeed, the removal of controls on credit, interest rates and international financial transactions combined with capital accounts' opening are expected to increase domestic and international private capital flows, thereby expanding the sector's depth and resulting in an increase of funds available to the economy. Moreover, the introduction of privatization and competition may significantly contribute to improving the banking sector's efficiency and reducing the cost of capital mainly through better management and by weeding out inefficient financial institutions. Similarly, developing countries' stock markets appear to be very responsive to policies undertaken by governments to promote their development such as the openness of securities markets to foreign investors, the implementation of tax incentive measures or the

development of depository and settlement systems.

Furthermore, stock markets liberalization is likely to lead to an increase in private capital flows and allow domestic and foreign investors to hold more diversified portfolios, which are in turn expected to improve markets' size and liquidity hence their efficiency. However, the 2007-2008 global financial crisis has re-opened the debate on the role of capital controls in limiting contagion and exchange risk. Indeed, FitzGerald (2007) argues that some public intervention is required to alleviate market failures and promote long-term investment in important sectors such as exports and infrastructure. The International Monetary Fund (IMF) agrees in 2012 that capital controls may be desirable "under certain circumstances" thereby leading to more research about the design and timing of inflows and outflows controls (The Economist, December 2014).

Consistent with the existing literature, our findings also demonstrate that country risk and institutional development are important determinants of financial depth and may therefore significantly influence the effects of reforms. In particular, the lower a country's risk and the more developed its institutions, the more its banking sector benefits from the positive effects of reforms. Therefore, when implementing reforms in an effort to develop their financial systems, developing countries should also put in place policies to promote the development of their institutions and reduce perceived investment risk.

## Chapter 2

# The relationship between financial development and private investment in the power sector

### 2.1 Introduction

In recent years, many countries in the developing world have experienced noticeably high economic growth while facing the challenges of rapid urbanization, demographic trends, climate change, and the induced increase in economic activity.<sup>11</sup> However, some observers have come to the conclusion that to sustain such growth prospects these countries would need to accelerate investment to rehabilitate, upgrade, and expand their infrastructures.<sup>12</sup> 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, along with a modernization of the financial sector (OECD, 2014). Given their public sector's limited resources, however, developing countries need to improve the quality of public spending in infrastructure as well as to attract more private investment to bridge the investment gap.

Infrastructure projects mobilize lumpy capital, are characterized by high economic stakes and long payback, and are exposed to political, economic and financial risks. Because they deliver future gains in local currency, these projects are usually financed with hard currency, and hence are exposed to currency devaluation and interest rates' volatility. While the private sector is expected to bring financing, expertise and efficiency to infrastructure projects, improving private participation in developing countries is challenging essentially due to their poor or non-existent credit-worthiness and under-developed financial sectors. With a mix of equity and non-recourse debt, Public-Private Partnerships (PPPs) came to be increasingly viewed as a way of improving private participation in developing countries' infrastructure projects.<sup>13</sup> Many of these

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<sup>11</sup> Over the 1990-2010 period considered in this chapter, the 56 developing countries included in our sample saw their GDP grow at an average rate of 3.7% while for a selection of 32 OECD countries it only grew at an average of 2.5%.

<sup>12</sup> Yepes (2008) suggests that developing countries need to invest approximately 5 to 7% of their GDP in infrastructure to be able to maintain economic growth in the 2008-2115 period at its current average rate of 5%. For a recent survey on the relationship between growth and infrastructure development, see Straub (2008).

<sup>13</sup> The borrower of a non-recourse debt is typically a special-purpose entity (PPP) created to own an infrastructure project. 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). For a detailed presentation

countries also implemented large-scale reforms of their infrastructure sectors in the late 80s early 90s in an attempt to promote competition and enhance private involvement.

After a sharp decline from relatively high levels in the mid-90s following liberalization reforms, annual private investment in infrastructure in these regions has stabilized in the 11 to 16 billion USD range since 2001 with a debt-equity distribution that significantly varies across regions. For instance, while bonds have become an important tool for financing infrastructure investments in the Latin America and East Asia regions, representing respectively 29% and 14% of investment during the 1996-2004 period, bond financing is nearly non-existent in the Middle East and North Africa region where about 98% of private investment in infrastructure has been in the form of loans from banks. Moreover, private participation in developing countries were more concentrated in the telecommunications and energy sectors, which respectively received 44% and 28% of investments in the 1990-2001 period (Kirkpatrick et al., 2006).

Strengthening the capacity of local financial markets to permit debt extension and equity financing with local currency under competitive terms is crucial to accelerating private participation in infrastructure. In the late 80s early 90s, many developing countries sought to develop their financial markets by implementing structural reforms, 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 (Huang, 2006). However, these efforts to develop appropriate local financial markets to support the financing of infrastructure projects have faced additional difficulties due to the fact that, given the high economic stakes they involve, these projects were exposed to great political interference.

While the need for developing countries to foster investment in infrastructure sectors has been largely emphasized in the literature, the issue of these countries' (limited) capacity to attract private capital remains somewhat weakly explored. This chapter seeks to contribute to filling this void. More specifically, given the reforms of the financial sector that have been implemented in various developing countries through the 80s and 90s, we seek to test whether the level of development of this sector is a good predictor of the amount of private participation in the financing of infrastructure projects, both when taken globally and when the banking segment and the stock market are separately treated. Focusing on the energy sector and controlling for

institutional quality, we specify random effects regression models for explaining investment with private participation that we fit to a 1990-2007 annual dataset on 56 developing countries.<sup>14</sup>

We find that, unambiguously, how well developed financial systems are matters to private investors seeking to enter the energy sector in developing countries. More specifically, the results show that the banking sector level of development is a good predictor of the extent of private participation in the funding of energy projects. Also, expectedly, we find that the levels of economic development, macroeconomic stability, and institutional quality and the degree of economic, financial, and political risks do influence private investors' decisions to enter the energy sector. Likewise, our findings highlight the higher interest of private investors in countries with greater needs for additional energy supply.

In line with Banerjee et al. (2006), our empirical analysis shows the quite thought provoking result that higher exchange rate risk and interest rates do not discourage private participation in energy projects. Another singular result that these authors find is that more corrupt countries tend to have more private involvement in energy projects financing. In our case, however, although the sign of the corruption variable coefficient suggests the same type of implications, it is not statistically significant. Altogether, the results obtained by these authors and, to some extent, ours, suggest that further to using available financial instruments and tools to mitigate risks inherent to energy projects, private investors rely on agreement schemes with governments or may bribe local authorities to further secure their investment or increase their long-term expected returns.

This chapter is organized as follows. The next section gives an account of this study's motivations and provides a review of some representative work on the role of infrastructure in growth and development, its financing, and the determinants of private participation in infrastructure projects. Section 3 discusses the data analyzed in this chapter, the main variables of interest, and 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 Appendix 2 gives further details on the data and some summary statistics.

## **2.2 Background and review of some related work**

The importance of infrastructure for poverty reduction and long-run economic growth in low-

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<sup>14</sup> Although public/government funds, private capital, and donors' aid all play a sizeable role in the financing of infrastructure projects, in this chapter we focus on the private participation in the funding of these projects.

income and developing countries has been highlighted since the 90s and has been since reinforced. In fact, 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). The popular view is that 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, 2011).

As in most parts of the world, infrastructure services in developing countries were traditionally provided by State-owned vertically integrated monopolies.<sup>15</sup> This model became plagued by poor performance due to various factors including political interference, inefficient management, and under-investment despite the fact that the existing infrastructures needed important upgrading and modernization. This situation has made the financing of infrastructure projects very challenging as demand has substantially increased following population growth and large-scale urbanization. Under limited resources, the public sector in developing countries cannot ensure adequate infrastructure funding together with the operational activities necessary to effectively provide quality of service.

To reduce the gap between demand and supply, partnerships between public and private sectors have been increasingly advocated. Public-Private Partnerships (PPPs) became one of the most popular mechanisms used to mobilize private capital for infrastructure projects funding. Indeed, partnerships between the public and private sectors were widely viewed as mechanisms that would allow gathering and channeling the needed amount of resources to sustain growth and alleviate poverty in developing countries. While local currency financing would have been preferred in most cases to avoid exposure to foreign exchange risk, infrastructure projects with private participation are often financed with a mix of hard currency-denominated equity and non-recourse debt.

Many developing countries undertook large-scale reforms of their infrastructure sectors in

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<sup>15</sup> 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, 2010). However, thanks to innovation, an increasing number of infrastructure services are becoming rival and excludable goods thus

the late 80s early 90s with the objectives of promoting competition through liberalization, improved regulation, and involvement of private and foreign actors in infrastructure ownership, management, operations, and service provision. Despite these reforms, however, developing countries still have to enhance private sector involvement in infrastructure financing. Indeed, between 1997 and 2004, these countries received only a small share of private investment and Africa attracted less non-recourse debt than other regions. Moreover, most of the bond financing in Africa during this period was for South-African projects through local currency issues in the domestic capital markets (Sheppard et al., 2006).

Stimulating private participation in the provision of infrastructure services is challenging and even more so for low-income and developing countries. It is often argued that the difficulties faced by developing countries for attracting private investors in infrastructure sectors are essentially due to their poor or non-existent sovereign creditworthiness and under-developed financial markets.<sup>16</sup> The World Bank (2006) has highlighted that the susceptibility of projects to governance, corruption, rule of law, and political interference may alter private investment. Projects design, risks identification and allocation, the availability of risk mitigation financial instruments and long-term financing, 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, 2010, Sheppard et al., 2006, Saidi, 2006, Jerome, 2011, Platz, 2009).<sup>17</sup>

Although the depth and composition of local capital markets significantly affects their ability to mobilize capital, their actual capability to provide infrastructure financing depends on other factors, including the size of the domestic economy, the level of income per capita, macroeconomic stability, and the development of contractual savings institutions such as pension funds and life insurance (Sheppard et al., 2006). Estache and Philippe (2012) argue that low private participation in many countries is rather due to poor access to international capital markets and even more so since the recent financial crisis that worsened investors' risk aversion and many commercial banks' lending capacity. All these factors make investing in infrastructure projects economically risky in developing countries and hence alter private investors' confidence

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questioning the necessity of public intervention for supplying them.

<sup>16</sup> 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.

<sup>17</sup> South Africa is an exception in the Sub-Saharan African region with a relatively well-developed financial system capable of providing long-term local currency funding for infrastructure projects (Calitz and Fourie, 2010).

and investment decisions.

In recent years, commercial banks in developing countries have gained increased exposure to non-recourse project financing in loans clubs or syndicates led by major international banks. Yet, due to their difficulties to mobilize long-term financing, their overall ability to extend long-term loans in local currency to infrastructure PPP projects is significantly impeded (Sheppard et al., 2006).<sup>18</sup> Moreover, bond and secondary markets are embryonic or non-existent in most developing countries and thus cannot offer financial instruments and risk mitigating tools which are required for infrastructure projects. Even though since the mid-90s many developing countries have implemented structural reforms to further deepen their financial sectors, they may have not yet reached the level of development that would significantly catalyze private investment in infrastructure.

To the best of our knowledge, very few empirical analyses have conducted a systematic investigation of the role of the banking sector and stock markets in attracting private investors in infrastructure projects. Furthermore, most of the studies investigating the determinants of private investment in developing countries have considered private capital flows to the economy as a whole or to all infrastructure sectors, which may make it difficult to draw sector-specific policy implications. In this study, we focus on the energy sector on which we collected data as recent as 2007, consider first the impact on private investors' decisions to enter this sector of the development of the financial sector as a whole and then investigate the relevance of distinguishing between the banking sector and the stock market in the analysis. Let us give a brief account of the findings of some representative studies that are related most to our work before moving on to presenting our empirical strategy.

Analyzing the determinants of private investment in the overall economy during the 1970-2002 period for the case of Ghana, Frimpong and Marbuah (2010) find that inflation, real interest rate, openness, and real interest rate have a significant effect on private investment flows both in the short and long run. In contrast, the level of public investment and constitutional law seem to impact private investment only in the short-term while external debt does in the long-term. 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 liberalization of the investment regime is the most significant institutional determinant of private investment.

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<sup>18</sup> Financial intermediaries facilitate transactions, collect savings, and allocate capital. An under-developed financial system may prevent households from accessing banks and other institutions to deposit their savings.

In their investigation of the determinants of private investment in infrastructure using a panel dataset on 40 developing countries from 1990 to 2000, Banerjee et al. (2006) highlight that property rights and bureaucratic quality improve private investment while, somewhat surprisingly, countries with higher levels of corruption attract more private participation in infrastructure projects. They argue that bribery may be a way for private investors, multinational corporations in particular, to gain deals or benefit from private gains. More directly related to our work, these authors find that although the development of stock markets has a positive sign its effect on private investment is not statistically significant.

Exploring the factors that influence public-private partnerships (PPPs) in infrastructure projects in low and middle income countries using a dataset that spans the 1990-2003 period, Hammami et al. (2006) provide evidence that public debt, high demand and market size, macroeconomic stability, and institutional quality all have a significant impact on PPPs. In particular, less corrupt countries with more effective rule of law receive more private financing. At a more macro level, the analysis of the determinants of private capital flows in 61 developing countries over the period 1970-2003 performed by Kinda (2008) shows a significant positive relationship between physical infrastructure and the level of development of the banking sector as reflected in the volume of credit granted to the private sector.

Kirkpatrick et al. (2006) and Basilio (2010) report similar results for LMICs using data that span the 1990-2002 and 1990-2007 periods respectively. Kirkpatrick et al. (2006) find that foreign direct investment (FDI) flows significantly increase with good governance and regulation whereas they decrease with exchange rate volatility. Basilio (2010) draws attention to the positive role played by the participation of multi-lateral development agencies (MDAs) in infrastructure projects funding on private investors. The author also points out to the adverse effect of political risk on private participation. Unexpectedly, domestic banks' liquid assets are found to dampen the contribution of private investors to project financing, thereby suggesting that some countries rely on foreign investment to compensate local financial institutions' lack of lending capacity.

## **2.3 The Data**

To investigate the importance of a country's financial sector's development on private participation in its energy sector projects' financing, 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 2.1 below. Out of these 56 countries, 41 are middle income countries (MIC) with active enough financial sectors so as to allow us to capture any potential

effect of overall economic and financial development on private participation.<sup>19</sup> The most prominent LMICs with active domestic banks in the project finance market are China, India, Malaysia, South Africa, and Thailand. Moreover, a number of these countries implemented sound reforms of their energy and financial sectors during the period covered by our sample in an attempt to attract more private capital.

Table 2.2 below gives the list of variables on which data have been collected and the expected effects of the explanatory variables. More detailed information on these variables is given in Table A2.1 of Appendix 2. The dependent variable of our analysis "Private participation in energy projects" is from The World Bank Public-Private Infrastructure Advisory Facility (PPIAF) database and labeled *privpart*. For a given country, this variable represents the total investment commitments with private participation in both electricity generation, transmission, and distribution projects and natural gas transmission and distribution projects at the time of the signature of the Private Participation in Infrastructures (PPI) contract.

Projects are classified in four categories, namely, concessions, divestitures, greenfield projects, management contracts, and lease contracts. A given project is said to have private participation if a private company or investor bears a share of the project's operating risk and we consider projects where private parties have at least 25% participation, except for divestitures which are included with at least 5% of equity owned by private parties. However, no distinction is made between public or private financing sources and between domestic or foreign investment. Investment volumes are expressed in 2010 USD and we take the natural logarithm of these volumes.<sup>20</sup>

The selection of control variables was mainly motivated by the need to be able to compare our results to those of existing empirical work and by data availability. The independent variables of main interest are grouped under the label "Financial sector development" and extracted from The World Bank's Financial and Structure database. As pointed out earlier, strengthening the capacity of developing countries' financial sectors so they can extend debt and equity financing instruments denominated in local currency in competitive terms is crucial to accelerating the

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<sup>19</sup> 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 shown in the appendix, summary statistics show enough variance in the data so that selectivity bias shouldn't be a concern.

<sup>20</sup> A more suitable dependent variable would have been private investment in energy projects as a share of GDP, controlling for the volume of public investment to examine any crowding-in or crowding-out effect. Unfortunately, these data are not consistently available for a reliable econometric analysis and investment with private participation as a share of GDP is negligible for our sample countries with relatively little variation.

private sector's involvement in infrastructure. In this chapter, we seek to test the hypothesis that financial development has contributed to the improvement of the energy sector's attractiveness to private investors in developing countries. The index *findev* measures the overall development of a country's financial sector and is calculated as the first principal component of variables that represent the depth of the banking sector, *liqliab*, and that of stock markets, *smt*, respectively.<sup>21</sup> The variable *liqliab* represents the liquid liabilities of domestic banks as a share of GDP while *smt* is a market turnover ratio equal to the quotient of total value of traded shares to average market capitalization.

In addition to these financial variables, we use some indicators of a country's institutions' quality and risks taken from the International Country Risk Guide (ICRG) dataset.<sup>22</sup> Indeed, the development of a country's institutions matters for the proper implementation of financial reforms, hence for financial development, which itself is closely related to economic development. The set of variables grouped under the label "Institutional quality and risk" includes countries' level of economic, financial and political risk (*countryrisk*), exchange risk (*exchrisk*), degree of corruption (*corruption*), and observance of law (*laworder*). High political, financial, and economic risks are factors that may prevent investors from participating in the funding of infrastructure projects. Furthermore, a high exposure to exchange risk may discourage foreign investors especially if domestic financial sectors are not developed enough to offer suitable risk-hedging instruments. In contrast, a well-functional legal system is expected to boost private investors' participation in energy projects as it ensures contracts' enforcement and property rights' protection.

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 increase business uncertainty and operational inefficiencies and raise the cost of doing business. According to the Multilateral Investment Guarantee Agency (MIGA, 2012), corruption is one of the most important factors that may prevent middle to long-term foreign investment in developing countries. However, not entering a market is not always an attractive option for multinational firms, especially in the case of infrastructure sectors where the first entrant can earn a monopoly position. Furthermore, investors may bribe countries' local officials to further protect their investment (Banerjee et al., 2006).

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<sup>21</sup> Our motivation for using these financial variables' first principal components is parameter parsimony.

<sup>22</sup> Kaufman et al. (2003) have constructed a more recent dataset on institutional quality but using it would substantially reduce the efficiency of our estimators, as the data are only available starting end of 1996.

**Table 2.1 - 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
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

The last four variables falling under the label of "Control variables" in Table 2.2 are taken from The World Bank World Development Indicators (WDI). The first variable, *gdp*, stands for real GDP in 2000 USD and measures overall economic development. One would expect that countries with higher GDP 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 second variable, *inflation*, is the overall inflation rate in the economy taken as a measure of macroeconomic stability. High inflation is likely to have a negative effect on private investment through both firms' willingness to contribute to infrastructure financing and consumers' ability to pay for services (Banerjee et al., 2006). Moreover, combined with political and financial risk, macroeconomic instability worsens investment uncertainty. As they are likely to be endogenous in our models, we use one-year lagged *gdp* and *inflation* as independent variables.

The third variable, *intrate*, is real interest whose effect on private investment is somewhat difficult to predict but foreseen to be negative. Indeed, viewed as the opportunity cost of engaging in an investment activity, an increase in real interest rates may make potential investors retreat from infrastructure projects for more profitable ones, which would lead to a decrease in private investment (Gjini and Kukeli, 2012, Pargal, 2003). However, real interest rate can also be viewed as the cost of capital in which case high rates may lead to lower credit to the private sector, hence less deep financial sectors and lower private financing of infrastructure projects. The fourth and last control variable, *tdlosses*, captures transmission and distribution losses in the power network as a share of total output, which is meant to measure the level of quality and efficiency of the infrastructure stock. The effect of this variable may be ambiguous as low technical efficiency draws more private participation but poor quality of the existing network may also discourage investors (Banerjee et al., 2006).

**Table 2.2 - Variables and designation**

Variable	Designation	Expected effect
Private participation in energy projects		
<i>privpart</i>	Natural logarithm of investment commitments (2010 USD) with private participation in energy projects	
Financial sector development		
<i>liqliab</i>	Domestic banks liquid liabilities to GDP: measures the absolute size of the banking sector based on liabilities	Positive
<i>smt</i>	Stock market turnover ratio calculated as the ratio of value of shares traded during a period to average market capitalization: measures markets' efficiency	Positive
<i>findev</i>	Overall financial development index: calculated as the 1 <sup>st</sup> principal component of variables <i>liqliab</i> and <i>smt</i>	Positive
Institutional quality and risk		
<i>countryrisk</i>	Country risk index: measures political, financial, and economic risk. Ranges from 0 to 100 and the higher the rating the lower the risk	Negative
<i>corruption</i>	Corruption index: ranges from 0 to 6 and the higher the score the less corrupt the economic system	Ambiguous
<i>exchrisk</i>	Exchange rate (stability) risk index: ranges from 0 to 10 and the higher the score the lower the risk	Ambiguous
<i>laworder</i>	Law observance index: ranges from 0 to 6 and the higher the score, the better the legal environment	Positive
Control variables		
<i>gdp</i>	Natural logarithm of real GDP (2000 USD, lagged)	Positive
<i>inflation</i>	Natural logarithm of inflation rate (% , lagged)	Negative
<i>intrate</i>	Real interest rate (%)	Ambiguous
<i>tdlosses</i>	Electricity transmission and distribution losses (% of output): measures the technical efficiency of the electricity network	Positive

Table A2.2 given in Appendix 2 presents some descriptive statistics of the data. We see that, on average, the countries in the sample received 1% of GDP in investment with private participation during the 1990-2007 period of study, with the highest share being for Bolivia in 1998 (27%). Simple correlation coefficients, in particular between the variable representing investment in energy projects with private participation and independent variables, are given in Table A2.3 of Appendix 2. The variables that are in a strong (linear) relationship with private participation as captured by a relatively high correlation coefficient are *findev*, *smt*, *gdp*, *intrate*,

and *exchrisk*. Multicollinearity does not seem to be an issue for correlation coefficients are lower than 0.50 as can be seen from Table A2.3 of Appendix 2. 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 for the case of the financial variables of interest in this study by means of causality tests.

More specifically, we ask whether there exists a causal relationship between private participation in energy projects, the variable *privpart*, on the one hand, and the variables that proxy financial development, namely, *liqliab*, *smt*, and *findev* on the other hand. To this end, we apply a standard Granger-type causality testing procedure suited for panel data (Hurlin and Dumitrescu, 2012). 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, which are presented in Table A2.4 of Appendix 2, confirm the existence of a causal relationship that runs from *smt* and *findev* to *privpart* while opposite causal relationships hold for all the financial variables. These results therefore suggest that these financial development variables may be included as predictors of private participation in energy projects in the econometric regression analysis to which we now turn.

## 2.4 Empirical analysis

To evaluate how important the development of a country's financial sector is to private investors' decision to enter this country's energy sector, we specify regressions where the natural logarithm of the real volume of investment with private participation in energy projects is the dependent variable. Part from financial variables, the set of right-hand variables of these regressions comprises variables that capture some important features of the sample countries' macroeconomic and institutional environment defined in Table 2.2. Of particular interest to us is the role that the country risk and the quality of institutions have played in building private investors' confidence.

The empirical strategy is organized around two objectives. First, we investigate whether or not the development of a country's financial sector is a good predictor of private participation in its energy sector projects' funding. Then, we further explore the effect, if any, of the financial sector's level of development on private participation by examining the relative weight of the

banking sector and the stock markets. We tackle the first objective by means of regressions of the following general form:

$$privpart_{it} = \alpha_0 + \alpha_1 findev_{it} + \sum_{k=1}^8 \gamma_k X_{it}^k + \varepsilon_{it} \quad (2.1)$$

where the indices  $i = 1, 2, \dots, 56$  and  $t = 1, 2, \dots, 18$  refer to the country and the year respectively, the variables *privpart* and *findev* are as defined in the previous section,  $\alpha_0$  is a constant term,  $\alpha_1$  is the coefficient associated with the financial development index *findev*, the  $X^k$ 's are the control variables that are presented in Table 2.2 under the labels "Institutional quality and risk," and "Control variables," the  $\gamma$ 's are their respective coefficients, and  $\varepsilon$  is an error term.

To achieve the second objective, we disaggregate the measure of overall financial development into its banking and stock markets components as measured by the variables *liqliab* and *smt* defined in the previous section. The following general equation is then specified:

$$privpart_{it} = \alpha_0 + \alpha_1 liqliab_{it} + \alpha_2 smt_{it} + \sum_{k=1}^8 \gamma_k X_{it}^k + \varepsilon_{it} \quad (2.2)$$

Given the time-series-cross-sectional nature of our data, we may fit a fixed-effects (FE) or a random-effects (RE) model to these data. While the FE estimator is consistent, it is well known that the RE estimator is more efficient. For the purpose of our analysis though, we discriminate between these two specifications by means of a Hausman test. This test is based on the assumption that in case of no correlation between explanatory variables and the random effects both FE and RE estimators are consistent but FE is not efficient. The results of such a test are reported in Table A2.5 of Appendix 2 and suggest that a RE specification is more appropriate for our data as we failed to reject the null hypothesis of no fixed effects.

We take the natural logarithm of variables *privpart*, *gdp* and *inflation* to reduce their variations and make them normally distributed. As pointed out earlier, we use one-year lagged values of macroeconomic variables to rule out endogeneity and adjustment lags. We also tested whether our variables contain a unit root through an Im-Pesaran-Shin or Fisher-type unit root test and failed rejecting stationarity. A Durbin-Wu-Hausman test allowed us to confirm explanatory variables' non-endogeneity. Finally, the models are estimated using standard errors that are robust to heteroskedascity and autocorrelation of the error term (Banerjee et al., 2006).

Table 2.3 below gives the RE parameter estimates of the baseline equation (2.1) that looks at the effect of the financial sector as a whole while Table 2.4 reports the estimation results of equation (2.2) that seeks to disentangle the effects of the banking sector and the stock market. Part from the parameter estimates, these tables report the number of observations actually used in

the estimation, *Obs.*, the coefficient of determination,  $R^2$ , and the Wald statistic for testing overall goodness-of-fit, *W*. We note that, due to the fact that the cross-sectional dimension (number of countries) largely dominates the time-series dimension (number of years) in our data, the values of the R-squared are rather low. However, the values of the Wald statistic show that our models fit quite well the data.<sup>23</sup>

The results of the regression model presented in Table 2.3 mostly confirm our main intuition. Indeed, the index *findev*, which synthesizes the degree of development of the financial sector, is significantly and positively related to the private participation variable, *privpart*. This says that the level of development of a country's financial system counts in the decision of private investors to participate in its energy projects. Part from this interesting result, from Table 2.3 we also see that a 1% increase in *gdp* yields a 0.46% increase in the volume of investment with private participation. This is consistent with the empirical literature that often claims that higher projected demand and consumers' ability to pay for energy infrastructure services is appealing to private investors.<sup>24</sup>

Another result that shows in the table is that a one point percent increase in the inflation rate diminishes private participation by 0.15%. This says that macroeconomic stability is definitely a signal that private investors use to decide whether or not to participate in energy projects in developing countries, an observation made by Banerjee et al. (2006). Also consistent with Banerjee et al. (2006) and Kirkpatrick et al. (2006), we find that higher electricity transmission and distribution losses are associated with higher private participation, suggesting that private investors' interest is stronger for countries with higher needs for additional energy provision.<sup>25</sup>

Moreover, we see that countries that are less politically, economically, and financially risky tend to attract more private investors into energy projects. Hence, economic and political instability creates an adverse climate for investment (Basilio, 2010). We also note that the variable *laworder*, which measures the quality of the legal system, has the expected (positive)

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<sup>23</sup> We indicate by \*, \*\*, and \*\*\* respectively significance at the 10%, 5%, and 1% level. To account for potential dynamics in private participation, we also examined some models that included the lagged dependent variable as an independent variable applying the Arellano-Bover (1995) and Blundell-Bond (1998) system-GMM. The results did not show any evidence of a significant effect of the level of past private participation. We also attempted to improve the models' goodness-of-fit by applying a "multiple imputation" procedure for filling missing data (von Hippel, 2007), but the results obtained were inconclusive. The results of these extensions of the empirical analysis are available from the authors upon request.

<sup>24</sup> See Pargal, (2003), Basilio (2010), and Kirkpatrick (2006) among others.

<sup>25</sup> It is worthwhile noting that the empirical literature often assumes that the efficiency of transmission and distribution networks is a reasonable proxy for the quality of public investment (Banerjee et al. 2006).

sign but is not statistically significant. Likewise, although the variable *corruption* is not statistically significant, it has the same sign as in Banerjee and al. (2016) who conclude that more corrupt countries draw more private participation.

In contrast with Pargal (2003) though, we find that an increase in real interest rates leads to an increase in the volume of investment with private participation. Similarly, the analysis shows that private participation tend to increase with exchange rate risk, hence contradicting an idea sometime put forward in the empirical literature (see, e.g., Kirkpatrick et al., 2006) that high volatility of exchange rate should dissuade foreign private investors from committing to energy projects. These results deserve a few comments.

First, investors willing to participate to these projects' financing rely on available financial instruments to hedge risks associated to energy projects. Indeed, PPPs usually include a contractual insurance coverage to mitigate risks, especially those that cannot be controlled by participating parties. For instance, risks coverage is often a pre-condition to banks' contribution to a PPP (OECD, 2014). This explanation is supported by the positive and significant effect of financial development on private participation (see Table 2.3) as a more developed financial sector offers more equity and debt instruments and risk-hedging tools, thereby improving the attractiveness of energy projects to private investors.

Second, as mentioned earlier, if the interest rate is viewed as the cost of capital, our result only reflects the property of a standard downward-sloping demand function. Third, it is important to bear in mind that around 80% of the investment in developing countries' infrastructure projects comes from foreign investors and that some form of public intervention may be desirable to foster their participation in case an acceptable risk/return profile cannot be attained (OECD, 2014). Hence, our result might reflect the fact that these investors have been benefiting from governments and international development agencies guarantees to improve perceived risks (Basilio, 2010).<sup>26</sup>

Finally, although the effect of the variable *corruption* is not statistically significant in our analysis, the literature provides some empirical evidence that bribery to win large PPI deals and gain important private returns at the expense of public interest may also explain why foreign investors can still choose to contribute to energy projects despite a high exchange risk or the availability of other seemingly more profitable projects (Banerjee et al., 2006).<sup>27</sup>

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<sup>26</sup> Given that our analysis does not distinguish public and private investments, the most obvious form of public intervention is financial back up.

<sup>27</sup> Note that the sign of the coefficient associated with the variable *corruption* found in our analysis does not

**Table 2.3 - Overall financial development (*findev*) regression parameter estimates**

Variable	Coefficient	Std. error
<i>findev</i>	0.11*	0.07
<i>gdp</i>	0.46***	0.11
<i>inflation</i>	-0.15*	0.09
<i>intrate</i>	0.04***	0.01
<i>tdlosses</i>	0.05***	0.02
<i>corruption</i>	-0.07	0.13
<i>countryrisk</i>	0.07***	0.02
<i>exchrisk</i>	-0.28***	0.07
<i>laworder</i>	0.10	0.14
<i>intercept</i>	0.41	2.59
<i>Obs.</i>		256
<i>R<sup>2</sup></i>		0.36
<i>W</i>		83.34***

The results found so far confirm our conjecture that the development of the financial sector is key to private investors' decision to invest in energy projects in sample countries. To determine which of the banking sector or stock markets matter the most, we disaggregate the index *findev* into its *liqliab* and *smt* components and regress the variable that measures energy projects' investment commitments with private participation on these variables, controlling for the institutional and macroeconomic environment. Equation (2.2) is thus estimated using the same methodology as previously and Table 2.4 below presents the results obtained.

**Table 2.4 – Banking sector and stock markets development (*liqliab* and *smt*) regression parameter estimates**

Variable	Coefficient	Std. error
<i>liqliab</i>	1.11**	0.46
<i>smt</i>	-0.08	0.14
<i>gdp</i>	0.47***	0.11
<i>inflation</i>	-0.14	0.09
<i>intrate</i>	0.04***	0.01
<i>tdlosses</i>	0.06***	0.02
<i>corruption</i>	-0.04	0.14
<i>countryrisk</i>	0.06***	0.02
<i>exchrisk</i>	-0.27***	0.07
<i>laworder</i>	0.11	0.14
<i>intercept</i>	-0.24	2.60
<i>Obs.</i>		256
<i>R<sup>2</sup></i>		0.37
<i>W</i>		82.96***

contradict the implications of these studies.

Table 2.4 shows that developing countries with a deeper banking sector received more private participation. It appears then that the channel through which the positive effect of overall financial development on private participation in energy projects demonstrated earlier is transmitted is the banking sector. Indeed, consistent with Banerjee et al. (2006) and Kinda (2008), the coefficient associated to the variable *liqliab* is statistically significant with a one-point increase of the volume of domestic banks liquid liabilities as a share of GDP yielding a 1.1% increase in private participation in energy projects.

The coefficient associated with the variable that measures stock market efficiency, *smt*, turns out not to be significant suggesting that, given the embryonic state of developing countries' stock markets, the attractiveness of their financial systems to private investors basically dwells on the quality of their banking sector. Indeed, one expects domestic funding of large-scale projects to be more banks loans-based, which explains the higher share of foreign investment in developing countries' infrastructure projects (Kirkpatrick, 2006). This suggests that a banking sector that permits to efficiently mobilize savings, hence has a good lending capacity to the private sector, encourages private investors' participation in developing countries' energy projects.

As in the previous analysis, our results show that overall country risk has a significant adverse effect on private investors' participation in energy projects. We also note that the effects of the corruption index and the indicator of countries' legal system's effectiveness remain statistically insignificant. The results that high interest rate and exchange risk do not discourage private commitment in energy projects' funding also shows in this more disaggregated regression. Countries' wealth, as measured by countries' real GDP, continues to be a key determinant of private participation while inflation is no longer statistically significant. The results also show that objective needs for more efficient networks (with less energy losses) draw private participation in energy projects.

## 2.5 Conclusion

By incorporating some key variables reflecting the level of development of a country's financial sector in the set of potential predictors of the volume of investment in energy projects with private participation, our objective in this chapter was to highlight the important role played by the financial sector in attracting private capital. We analyzed a dataset consisting of observations on 56 developing and emerging countries for the 1990-2007 period characterized by intense liberalization and foreign direct investment. Overall, our results confirm our conjectures but some

results, related to risk, are not consistent with some of the findings of the empirical literature and those are given some interpretation.

Our empirical analysis showed that the development of a country's financial sector is a good predictor of the volume of investment with private participation flowing into this country's energy sector. More specifically, a well-established and well-functioning banking sector is found to improve the business environment in developing and emerging countries and hence foster private participation in energy projects in these countries. As expected, economic development and macroeconomic stability, institutional quality and economic, financial, and political risk are also found to influence private investors' decisions to enter the energy sector. Likewise, our findings highlight that private investors' interest is rather for countries with higher needs of additional energy provision.

The estimation results also show that high exchange risk or interest rates do not seem to discourage private participation. The most obvious explanation of this result is that investors willing to participate to these projects' financing rely on available financial instruments to hedge risks associated to energy projects, in particular when the financial sector is developed enough to offer more equity and debt instruments and risk-hedging tools, thereby improving the attractiveness of energy projects to private investors. Moreover, investors may benefit from guarantees from the public sector and international development agencies to improve perceived risks, especially when an acceptable risk/return profile cannot be attained. Even though the empirical evidence is not strong, our results do not contradict the existing literature that suggests that bribery to win large PPI deals and gain important private returns at the expense of public interest may also explain why foreign investors can still choose to contribute to energy projects despite a high exchange risk or the availability of other seemingly more profitable projects (Banerjee et al., 2006).

A strong implication of our empirical analysis is that, in their effort to attract private investors into the energy sector, policy makers in developing countries should give great consideration to deepening their domestic banking sectors and developing stock markets. One clear benefit that developing countries could expect to tap from reforming their financial sectors is to draw private investment that lacks so much in the infrastructure industries. This can be achieved by putting in place sound institutional frameworks to ensure the proper implementation and sequencing of financial reforms, by promoting a properly regulated intermediation framework such as pension and mutual funds, and insurance companies to mitigate perceived risks, and by bringing to market sound and bankable projects.

Financial reforms and liberalization should result in an increase in the size and liquidity of financial systems, which would in turn increase the amount of credit granted to the private sector (McKinnon, 1973, Shaw, 1973). Furthermore, these reforms are expected to help reduce the cost of capital and improve the sector's efficiency (Chinn and Ito, 2006). By allowing both domestic and foreign investors to benefit from more risk-hedging instruments and hold more diversified portfolios, financial markets' opening can make long-term investment more attractive for infrastructure projects financing (Bekaert and Harvey, 2000, Bekaert et al., 2005). The severe negative impact of the recent financial crisis on PPP, namely, the important drop in the number and value of projects reaching financial closure, reinforces our conclusion that a robust and sound economic and financial framework is essential for sustainable infrastructure projects.<sup>28</sup>

This analysis provides useful insights to feed into the debate on the key factors that may help improve infrastructure financing and servicing in developing countries and contribute to further research on the net effects of perceived risks and corruption. More work is needed to assess the impacts of infrastructure sectors' regulatory institutions' characteristics on private participation. Indeed, the data that would allow us to explore these issues are only available for some regions (Andres et al., 2009, Kirkpatrick, 2006). In a future research, we will investigate the existence of yet another benefit steaming from the policy reform of the financial sector, namely, a positive externality that this reform exercises on the performance of the infrastructure sector's reforms themselves.

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<sup>28</sup> This conclusion has been also reached by Basilio (2010).

## Chapter 3

# To what extent do infrastructure and financial sectors reforms interplay? - Evidence from panel data on the power sector in developing countries

### 3.1 Introduction

As in most parts of the world, infrastructure services in developing countries were traditionally provided by stated-owned vertically integrated monopolies. However, this model has become plagued by poor performance due to various factors including political interference, inefficient management, and under-investment. This situation has led to a soaring need to upgrade networks and 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. With limited resources, the public sector alone in these countries cannot ensure adequate funding together with the operational activities necessary to provide access to and quality of service.

In the late 80s and early 90s many developing countries conducted important structural reforms of their infrastructure sectors and gave high priority to the objective of reducing the financial burden on the public budget by promoting foreign and domestic private investment in these sectors. In the case of the power sector, although they varied across countries to some extent, the implemented reforms mainly consisted of a combination of four policies, namely, the unbundling of the generation, transmission, and distribution activities of the vertically integrated utilities, the privatization of the generation and distribution segments of the industry, the introduction of competition in the generation and distribution segments, and the creation of an autonomous regulatory authority. In parallel to these sectoral reforms, large efforts were made to modernize and develop financial systems, in particular, to encourage private participation in infrastructure projects.

The couple privatization-competition is meant to enhance efficiency, innovation, and customer responsiveness while independent regulation, as an alternative to centralized regulation by a government department, is expected to improve investors' confidence and consumers'

protection.<sup>29</sup> Indeed, basic microeconomic theory says that competition and ownership are key determinants of the levels of outputs, costs, and prices, and hence of the level of allocative and productive efficiency in the market.<sup>30</sup> Hence, provided they are properly designed and implemented, the reforms of the power sector conducted in developing countries should be expected to enhance industry performance as reflected in higher access and usage demand and greater efficiency of supply.<sup>31</sup>

In practice though, the power sector reforms encountered great difficulties in many developing countries due to institutional weaknesses and lack of modern financial systems crucial to sustain the development of a sector that necessitates large capital investments. The fact is that both the establishment of appropriate regulatory bodies and the building of capacity have followed such a slow and complex process that observers have come to question the efficiency of the sectoral reforms and the timing of their introduction (Cubbin and Stern, 2006, Zhang et al., 2008). This chapter seeks to feed in the academic debate on the issues of the performance of the power and financial sectors' reforms and the extent to which these reforms interplay.

This chapter is organized as follows. The next section reviews some relevant studies on the impact of the power sector's reform on industry performance. We then specify in Section 3 the main findings of this literature as to the impacts of the reforms and financial development, in the form of some empirically testable hypotheses. Section 4 describes the data. Section 5 presents the econometric approach used to analyze them, reports the specified econometric models results, and discusses the outcome of the hypotheses tests. Section 8 concludes and Appendix 3 provides some complementary material.

### **3.2 The performance of the power sector reforms**

The major part of the literature that has attempted to evaluate the performance of the infrastructure industries' reforms has been concerned with developed countries and among the studies concerned with developing countries only few have examined the electricity industry.<sup>32</sup> This gap is due to both the lack of consistent data on the sector that are suitable for rigorous econometric analysis and the difficulty in constructing accurate indicators of the various power

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<sup>29</sup> For more on these points, see, e.g., Jasmab et al. (2005) and Zhang et al. (2008).

<sup>30</sup> See Vickers and Yarrow (1988).

<sup>31</sup> In the case of the power sector though, this argument should be moderated due to the fact that it possesses some natural monopoly characteristics that may weaken the positive effects of competition.

<sup>32</sup> Being historically at the forefront of the wave of reforms that has profoundly reshaped infrastructure sectors worldwide, the telecommunications industry reforms have been subject to far deeper empirical analysis. Among

reform policies implemented by developing countries. In this section, we briefly review some studies that are most related to our work as to their objectives and methodology.

An important component of the power sector reform is the unbundling of vertically-integrated electricity utilities into corporatized generation, transmission, and distribution usually coupled with a change of ownership and management principles in the generation and distribution segments, and the introduction of competition in these segments. The literature on the incentive effects of ownership structure (see, e.g., North, 1990, Levy and Spiller, 1996) and agency and public choice theories (see Niskanen, 1971, Boycko and Vishny, 1996, among others) provide useful insights on the impact of privatization on economic performance. Privatization is expected to improve economic efficiency by (i) Changing the allocation of property rights resulting in different incentives for management; (ii) Removing the budget constraint of taxpayer support and exposing firms to the discipline of the private capital market; (iii) Setting more precise and measurable objectives, such as loss reduction, thereby decreasing transaction costs, in particular, those related to management monitoring by principals; (iv) Removing political interference with management.

When applying these theoretical arguments to the electricity industry, however, it is important to account for the specific characteristics of the sector.<sup>33</sup> Electricity production is traditionally viewed as an industry with large sunk costs, generally exhausted economies of scale, and non-storable and massively consumed output which may lead to government opportunistic behavior that affects private actors' incentives to invest. Consequently, that privatization would necessarily lead to capacity expansion is not guaranteed. Nevertheless, it is safe to say that technical and operating efficiency may be expected to improve following privatization and this is likely to result in more efficient utilization of installed capacity, capital, and labor.

Competition is viewed as a reliable mechanism to improve allocative, productive, and technical efficiency. Indeed, in a competitive market, prices should reflect firms' costs and productive efficiency and hence, by putting downward pressure on prices, competition can be expected to increase technical and operating efficiency as well as labor productivity. The improved technical efficiency may lead to lower prices, hence to higher demand which in turn is likely to increase capacity and supply (Leibenstein, 1966, Zhang et al., 2002). Nevertheless, the fact that some segments of the power sector possess some natural monopoly properties may

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others, see Fink et al. (2003), Gasmi and Recuero Virto (2010), Ros (1999), and Wallsten (2001).

<sup>33</sup> In addition to these sector-specific characteristics, one should not ignore local economic conditions. See Gasmi et al. (2012) on this point in the case of telecommunications.

weaken these positive effects of competition.

The literature also highlights that governance and regulation matter for the performance of infrastructure industries in general, and for that of the power sector in particular. More specifically, a regulatory body independent from the government and with the required technical expertise appears to be the best model to ensure a well-functioning and efficient power sector. Furthermore, the existence of this regulatory authority should contribute to improving private participation in the financing of electricity projects as it implies a safer business environment (Cubbin and Stern, 2006, Andres et al., 2009). We can therefore assume that the creation of an energy sector regulator independent from the executive branch of government may help improving the performance of the power sector.

The existing empirical studies on the impact of reforms on performance of the electricity industry in developing countries have produced mixed results essentially due to the diversity of the econometric methodologies and the samples of countries analyzed. Gassner et al. (2009) investigate whether private sector participation in electricity distribution has improved economic performance in a panel of 71 developing and transition countries over the 1900-2002 period and report that labor productivity and operational efficiency have indeed increased.

Zhang et al. (2002) examine the impact of privatization, competition, and regulation on the electricity sector's performance using a dataset on 51 developing countries over the period 1985-2000. Their empirical results suggest that competition has positive effects on service penetration, capacity expansion, labor efficiency, and prices charged to industrial users. The authors also find that the interaction between privatization and regulation leads to greater electricity availability, more generation capacity, and higher labor productivity whereas their effect is not significant when taken separately.

Zhang et al. (2005) study the impact of the sequencing of privatization, competition, and regulation on the electricity industry performance using data on 25 developing countries from 1985 to 2001. While these authors find that individual reform indicators have no significant effect on performance, their study shows that the creation of a separate regulatory authority and the introduction of competition prior to privatization have led to higher generation capacity and production. They also find that the introduction of competition before privatization enhances capital utilization as measured by the ratio of electricity production to average capacity.

Zhang et al. (2008) extend their 2002 study (Zhang et al., 2002) by using some new measures of privatization, competition, and regulation, and examining the impact of the electricity industry reforms in a larger sample of 36 developing countries covering the period

1985 to 2003. They reach conclusions that are similar to those of their previous study, namely, that competition fosters electricity generating capacity, output, and labor productivity while privatization and regulation do not. They however find evidence of some positive effects of the interaction of privatization with regulation and competition on performance.

In contrast, Sen and Jasmab (2010) find in a sample of 19 Indian States from 1991 to 2007 that unbundling, privatization in distribution and regulation tend to worsen technical and operating efficiency, and that gross generation decreases with privatization. As to the effects of the reforms on electricity prices, these authors find that unbundling has no significant effect on average electricity price while the existence of an independent regulatory body is associated with a significant increase in the average industrial price.

Some studies have focused on the effects of regulation and governance on the performance of the electricity industry. Cubbin and Stern (2006) examine the impacts of the existence of a regulatory law and regulatory governance on the power generation segment's performance while controlling for privatization and competition. In a panel dataset on 28 developing countries covering the period 1980-2001, they find that both regulatory law and quality of regulatory governance have positive and significant effects on per capita generation capacity. Moreover, these impacts increase with the regulatory agency's experience and reputation.

Likewise, Andres et al. (2009) construct an index of quality of regulatory governance and investigate the impact of a change in ownership and of various characteristics of the regulatory agency on the performance of 250 electricity utilities in Latin America and the Caribbean from 1995 to 2005. They find that private sector participation significantly affects labor productivity, the network's technical efficiency, and quality of service in particular. These authors' results also indicate that, independently of ownership, the mere existence of a regulatory institution significantly enhances performance. They also find that the coefficients associated with the ownership dummies in the performance regressions have the expected signs and are significant. The results found by Cubbin and Stern (2006), namely that experience in regulation and quality of governance have significant effects on performance, are also confirmed by this study.

### **3.3 The role of the financial sector reforms: Some testable hypotheses**

The least one can say from the above overview of the empirical literature that seeks to evaluate the effects of the electricity industry reforms in developing countries is that the conveyed messages are somewhat mixed. In what follows, we attempt to structure the results discussed in this literature into a set of hypotheses for the purpose of testing them in our data. We take the

view that an explanation of the divergence of the results obtained might be that some important factors that affect the working of sectoral reforms and hence their impact on industry performance may have been omitted in the studies. Despite the fact that the importance of financial systems for development has been emphasized in the literature and that the impact of infrastructure sectors reforms on industry performance has drawn much attention, to our knowledge, the combined effect of infrastructure and financial sectors reforms on infrastructure sectors performance has remained relatively weakly investigated.<sup>34</sup>

This chapter seeks to contribute to filling this void by exploring the question of how the power and financial sectors reforms interplay. More specifically, we attempt to estimate the effect of the level of development of domestic financial systems on the impact of the power sector reforms on the performance of this sector in developing countries. We consider different dimensions of performance, namely, actual output, technical efficiency, labor productivity, and access, and argue that the level development of financial systems resulting from implemented financial reforms plays a non-negligible role in the determination of the outcomes of sectoral reforms. Hence, we incorporate in the analysis of the impact of sectoral reforms on industry performance their likely interaction with financial development.

At this point the reader might wonder why we focus on the effect of financial development resulting from financial reforms rather than on the financial reforms themselves. The reason for this is threefold. First, even though in the first chapter we used a set of indicators of the financial sector reforms, the number of those indicators is so large that incorporating them in the empirical analysis which is the object of this chapter would make the econometrics unnecessarily cumbersome and intractable. Second, the option of using directly these indicators of financial reforms would be "too costly" in terms of data because of incompatibility of datasets. Third, given that in the first chapter, we find a significantly positive relationship between these indicators and the measure of overall financial development, substituting the latter for the formers in the analysis would still allow us to conclude, as we argue next, on the existence of a significant interaction effect between the power sector reforms and the financial sector reforms.

As alluded to above, the work undertaken in this chapter should be viewed as part of a multi-stage empirical project. More specifically, in the first chapter, we find evidence of a positive link between financial reforms and the development of financial systems in a dataset on

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<sup>34</sup> The empirical literature on the role of financial development in developing countries economic growth includes Amable and Chatelain (2001), Ang and McKibbin (2007), Ben Naceur et al. (2008), De Gregorio (1999), Huang (2006), Klein and Olivei (1999), and Levine (2001).

54 developing countries covering the 1973-2005 period. Using a 1990-2007 dataset on 56 developing countries, in the second chapter we argue and confirm that the level of financial development is a key determinant of private participation in the energy sector, a necessary ingredient for the growth of this sector in developing countries. In this chapter, we seek to test the hypothesis that financial development enhances the impact of the power sector reforms on this sector's performance. Putting together the findings of the first and second chapters, an important policy implication of the empirical validity of this hypothesis would be consequently that infrastructure sectors' reforms should benefit from financial reforms.<sup>35</sup>

While our main objective is to perform an econometric test of the hypothesis that financial development strengthens the impact of the electricity industry reforms on this sector's performance, we also seek to contribute to the empirical literature on the evaluation of the outcomes of these reforms. To this end, we organize the various findings reported in the literature, although sometimes showing some degree of divergence, in the form of a set of hypotheses that reflect their main implications. Table 3.1 below describes these hypotheses that we designate by H1 through H4. This table also presents our conjecture on the positive role of financial systems in the working of the power sector reforms. For the sake of clarity of the exposition,  $\overline{H1}$  indicates the application of our conjecture to the reform that the hypothesis H1,  $I=1, 2, \dots, 4$  is concerned with. Hence, a non-rejection of the null hypothesis  $\overline{H4}$  say would mean that, all things equal, the data does not contradict the assertion that "financial development has made stronger the positive impact of the creation of an autonomous regulatory authority on the power sector's performance."

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<sup>35</sup> Of course this implication would be true only if the sign of the estimated coefficient reflecting the interaction between the financial development and power sector reform variables is positive.

**Table 3.1 - Testable hypotheses**

Hypothesis	Description
H1	Unbundling, competition, and private participation lead to higher output and access to electricity.
H2	Unbundling, competition, and private participation lead to higher operating and technical efficiency.
H3	Unbundling and private participation lead to higher labor efficiency.
H4	The establishment of an independent regulatory authority enhances industry performance.
$\bar{H1}$ through $\bar{H4}$	Financial development affects positively power sector performance through its interaction with the sector reform described in respectively hypothesis H1 through H4.

### 3.4 The data

To evaluate the impact of the power sector reforms on its performance in developing countries and investigate the role of the level of development of a given country's financial sector, we collected data on 42 developing countries in Latin America and Caribbean (LAC), Asia, Middle East and North Africa (MENA), and Sub-Saharan Africa (SSA) over the period from 1990 to 2005. Table 3.2 below lists these countries and gives the World Bank income group each of these countries belongs to.<sup>36</sup> Although the period spanned by our study, 1990 through 2005, was imposed to us by data availability, we must indicate that very little or no reform has occurred in developing countries before 1990. Moreover, our panel is unbalanced as not all the data were available for all the years and all the countries.

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<sup>36</sup> A country is considered as a lower middle income country when its 2008 GNI per capita is between \$976 and \$3,855, a higher middle income country when its 2008 GNI per capita is between \$3,856 and \$11,905, and a low income country when its 2008 GNI per capita is equal to \$975 or less.

**Table 3.2 - List of countries in the sample**

Country	World Bank region	World Bank income group
Argentina	Latin America & Caribbean	Upper 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
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
Dominica	Latin America & Caribbean	Upper middle 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
Grenada	Latin America & Caribbean	Upper middle income
Guatemala	Latin America & Caribbean	Lower middle income
Honduras	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
Malaysia	East Asia and Pacific	Upper middle income
Mexico	Latin America & Caribbean	Upper middle income
Morocco	Middle East & North Africa	Lower middle income
Nicaragua	Latin America & Caribbean	Lower middle income
Nigeria	Sub-Saharan Africa	Low income
Panama	Latin America & Caribbean	Upper middle income
Paraguay	Latin America & Caribbean	Lower middle income
Peru	Latin America & Caribbean	Lower middle income
Philippines	East Asia and Pacific	Lower middle income
South Africa	Sub-Saharan Africa	Upper middle income
Sri Lanka	South Asia	Lower middle income
St Kitts and Nevis	Latin America & Caribbean	Upper middle income
St Lucia	Latin America & Caribbean	Upper middle income
St Vincent and the Grenadines	Latin America & Caribbean	Upper middle income
Thailand	East Asia and Pacific	Lower middle income
Tunisia	Middle East & North Africa	Lower middle income
Turkey	Europe & Central Asia	Upper middle income
Uruguay	Latin America & Caribbean	Upper middle income
Venezuela	Latin America & Caribbean	Upper middle income
Zambia	Sub-Saharan Africa	Low income
Zimbabwe	Sub-Saharan Africa	Low income

Table 3.3 below exhibits the list of variables on which data have been collected.<sup>37</sup> The variables that measure power sector performance, the dependent variables, are those that are under the label "Electricity sector performance" in this table. These variables are net electricity generation per capita (*generationpc*), sales per employee (*salesperemp*), electricity losses in the transmission and distribution networks (*distlosses*), and the rate of electrification (*electrification*). These measures are meant to capture respectively the quantity of electricity supplied during a given year in a given country, labor efficiency, operating and technical efficiency in transmission and distribution, and the extent to which the population of a given country has access to electricity. All performance variables have been re-scaled by taking their natural logarithm to reduce their variance.

The independent variables of main interest are grouped under the labels "Electricity sector reforms" and "Financial development." The power sector reform variables comprise indicators of private participation in generation and distribution, unbundling, competition, and existence of a regulatory body independent from the executive branch of the government, typically from the Ministry of energy. Ideally, private participation in generation would be measured by the percentage of electricity produced by private companies or by the percentage of generation capital owned by private investors. Similarly, competition would be best measured by some sort of concentration ratio for each country's electricity sector and some information on the quality of regulatory governance in each country would have been suitable for the analysis too. Unfortunately, such quantitative data were not consistently available for all the countries in the sample and so far only limited information on the design of regulatory institutions in developing countries are available.

To circumvent these difficulties, we constructed dichotomous dummy variables indicating whether the electricity sector has been "unbundled" into its three segments (*unbundling*), whether there exists a wholesale market where generators can compete to conclude supply contracts with distributors or large users (*competition*), whether private participation exists in the generation segment (*ppgen*), and whether a separate regulatory authority not directly under the control of the executive branch of the government has been created (*sepreg*).<sup>38</sup> To capture experience in

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<sup>37</sup> More detailed information on the data and their sources and some descriptive statistics are given in Table A3.1 of Appendix 3. In the remainder of the chapter, the power sector reforms are sometimes referred to as the "sectoral reforms."

<sup>38</sup> These dummy variables were constructed on the basis of information collected from various regulatory reports and websites, which are listed in the references. We should mention that a wholesale market in generation is typically created when this segment is unbundled from transmission and distribution. Hence, the variables *unbundling* and *competition* should be highly correlated and indeed they are in our dataset with a correlation coefficient of 0.87. This

regulation, we also use a variable that indicates the number of years since the regulatory agency has been created (*expreg*). Private participation in distribution (*ppdist*) is measured by the percentage of the total number of connections supplied by the private sector.

**Table 3.3 - Variables and designation**

Variable	Designation
Electricity sector performance	
<i>generationpc</i> *	Net generation per capita (Kwhbn)
<i>salesperemp</i> *	Sales per employee (Mwh)
<i>distlosses</i> *	Distribution losses (% of total output)
<i>electrification</i> *	Electrification rate (% of total population)
Electricity sector reforms	
<i>ppgen</i>	Private participation in generation (dummy)
<i>ppdist</i>	Private participation in distribution (% of total connections)
<i>competition</i>	Competition in wholesale (dummy)
<i>unbundling</i>	Unbundling of generation, transmission, and distribution (dummy)
<i>sepreg</i>	Existence of separated regulator (dummy)
<i>expreg</i>	Experience of regulator (years)
Financial development	
<i>findev</i>	Financial development index (the higher the index the more developed the financial system)
Institutional quality and risk	
<i>countryrisk</i>	Country risk index (the higher the score the lower the risk)
Economic development and population distribution	
<i>gdppc</i> *	GDP per capita (2005 USD)
<i>urbanization</i>	Urban population (% of total population)

\* Variable transformed into its natural logarithm.

To measure the level of financial development, we use the variable *findev* which we calculate as the first principal component of some financial variables that capture the level of development of the banking sector and stock markets. For the banking sector we use the variable

led us to interpret and actually use these two variables in the regression analysis as substitutes for indicating that the power sector has experienced (some) openness to competition. Moreover, we should mention that the issue of

*liqliab*, expressed as a fraction of GDP, which represents the liquid liabilities of domestic financial institutions and hence captures the depth of the banking sector. For financial markets, we use the variables *smc* and *tv*. Also expressed as ratios of GDP, these variables represent, respectively, stock market capitalization and total value of shares traded on the stock market. They are meant to measure the size and liquidity of the capital market respectively.

In addition to variables of performance, sectoral reforms, and financial development, we use an indicator of the quality of a country's institutions and its level of risk as control variables. Presented under the label "Institutional quality and risk" in Table 3.3, this variable represent the country's overall level of political, financial, and economic risk (*countryrisk*). To account for economic development and urbanization effects that have been discussed in the literature (see, e.g., Zhang et al., 2002), we add real GDP per capita transformed into its natural logarithm (*gdppc*) and the share of the country's total population which lives in urban areas (*urbanization*) as control variables. These two variables are under the label "Economic development and population distribution" and are expected to improve performance. Let us now move on to presenting the econometric strategy and empirical results of this study.

### 3.5 Empirical analysis

To estimate the effects of sectoral reforms and financial development on the performance of the electricity industry, we run a set of single-equation regressions with the performance indicators as dependent variables. Part from the independent variables of main interest, namely, sectoral reforms and financial development indicators, the set of right-hand variables of these regressions comprises variables that capture some important features of the countries' institutional and economic environment. Thus, these regressions provide us with an empirical framework that can be used to test the hypotheses on the impact of sectoral reforms discussed in the previous section (see Table 3.1) while controlling for these other features of a country's economy.

This analysis has two objectives. A first objective is to test whether the power sector reforms had the expected effects on its performance, i.e., to test the hypotheses H1 through H4 described in the previous section (see Table 3.1). A second objective is to analyze the interaction between the power and financial sectors' reforms by examining the statistical significance of terms that cross the indicator of the level of financial development with the indicators of the power sector's reforms. The outcomes of this second exercise will thus inform us on the validity

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whether or not the regulatory agency is immune to political interference is not addressed in this chapter.

of the hypotheses  $\overline{H1}$  through  $\overline{H4}$ , i.e., of our main conjecture that financial development enhances the effectiveness of the power sector reforms.

To investigate whether the different dimensions of the power sector reform affect industry performance directly or through their interaction with financial development or both, we run regressions of the following form:

$$perf_{it} = \alpha_0 + \mu_i + \alpha_1 pp_{it} + \alpha_2 reg_{it} + \alpha_3 open_{it} + \alpha_4 findev_{it} + \alpha_5 pp.findev_{it} + \alpha_6 reg.findev_{it} + \alpha_7 open.findev_{it} + \sum_{k=1}^4 \gamma_k X_{it}^k + \varepsilon_{it} \quad (3.1)$$

where  $i = 1, \dots, 42$  and  $t = 1, \dots, 16$  are indices that refer to the country and the year respectively,  $perf$  is a variable of industry performance,  $pp$  is either  $ppgen$  or  $ppdist$  depending on the industry performance variable used,  $reg$  is either  $sepreg$  or  $expreg$  selected on the basis of goodness-of-fit,  $open$  is either  $unbundling$  or  $competition$  also selected on the basis of goodness-of-fit,  $findev$  is the index of financial development discussed earlier, the  $X^k$ s are the control variables under the labels "Institutional quality and risk" and "Economic development and population distribution" in Table 3.3 above, the  $\alpha$ s and  $\gamma$ s are unknown parameters,  $\mu_i$  is a fixed country-effect term, and  $\varepsilon_{it}$  is an error term.

Given that our data are in a pooled time-series cross-sectional form, it seemed natural to us to consider fixed-effects (FE) and random-effects (RE) models and discriminate between these two specifications by means of a Hausman test. We finally chose FE models that control for country-specific unobserved effects for three reasons.<sup>39</sup> First, the RE model assumes that the regressors are not correlated with the unobserved country effects. However, factors such as those related to the quality of governance and institutions are very likely to affect our measures of sectoral reforms and hence, when omitted, their impacts are included in the unobserved country-specific term leading to a correlation between this term and the regressors. Second, the countries included in the sample analyzed are clearly not drawn randomly but are developing countries for which relevant data were available. Finally, we have performed a Fisher test that confirmed the presence of country fixed effects in all the specified models.<sup>40</sup>

The model described by equation (3.1) is estimated for each of the electricity industry

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<sup>39</sup> This choice made, we nevertheless realize that, even if the FE estimator is always consistent, the RE estimator, where applicable, is more efficient (Sen and Jasmab, 2010).

<sup>40</sup> The results of this test are available from the authors upon request.

performance measures described in Table 3.3.<sup>41</sup> To alleviate multicollinearity problems, the sectoral reforms and financial development variables have been mean-centered. As the explanatory variables, in particular, the sectoral reforms and financial development variables, may be influenced by the power sector performance, we tested for their endogeneity in each model by means of a Durbin-Wu-Hausman test and used their lags as instruments when relevant. When a variable,  $x$  say, turned out to be endogenous, it is indicated in the tables by  $l.x$ .<sup>42</sup> Furthermore, bearing in mind that an adjustment period may be required for reforms to effectively boost the performance of the power sector, we estimated models with both the contemporaneous and (first) lagged reforms variables and their interaction with financial development and report the best results on the basis of goodness-of-fit.

Fitting the data to the model given by equation (3.1) allows us to examine the robustness of these individual and/or combined effects by regressing each of the performance measures on the power sector reform indicators, the financial development index, and the cross-term that captures their interaction. The estimation results are presented in Tables 3.4 through 3.7 below. Part from parameter estimates of the regressions, these tables report the number of observations actually used to estimate each model, Obs., the Fisher statistic for testing the joint significance of the independent variables,  $F(.,.)$ , and the  $R^2$  of the model.<sup>43</sup> As can be seen from the tables that exhibit the estimation results, both the  $F$  and the  $R^2$  show that the models fit rather well the data.

Table 3.4 below presents the estimation results when the industry performance (dependent) variable is "Net electricity generation per capita," *generationpc*, and both (lagged) potential separate and cross-effects of sectoral reforms and financial development are accounted for. We find that generation per capita significantly increases when private participation in the power sector is allowed, when an independent regulatory authority is established, and when financial development is strengthened. These results are in line with the argument advanced in the literature that these measures are the most effective reforms for improving electricity output (Zhang et al., 2005, Cubbin and Stern, 2006). A worthwhile making observation from Table 3.4 is that the variable that indicates the existence of an independent regulator is also significant

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<sup>41</sup> Prior to estimation, we made sure that the variables were stationary through testing and when appropriate differencing. We also calculate robust standard errors.

<sup>42</sup> For instance, the notation  $l.ppgen*findev$  would mean that the variable that crosses the sectoral reform variable indicating the existence of private participation in generation, *ppgen*, with the variable that indicates the level of financial development, *findev*, has been found to be endogenous, and hence has been instrumented by its lags. Detailed results on this procedure are available from the authors upon request. For a thorough discussion of the endogeneity of institutional variables in the case of the telecommunications sector the reader might check Gasmi and Recuero Virto (2012).

when crossed with the variable that measures the level of financial development. This suggests that a country with a financial sector developed enough to offer proper financial tools and funding is more likely to benefit from the creation of an independent energy regulatory authority.

**Table 3.4** - Electricity generation per capita (*generationpc*)  
regression parameter estimates

Variable	Coefficient	Std. error
<i>intercept</i>	-2.265***	0.814
<i>l.ppgen</i>	0.085***	0.020
<i>l.sepreg</i>	0.010***	0.002
<i>l.unbundling</i>	-0.060*	0.030
<i>l.findev</i>	0.026***	0.009
<i>l.ppgen*findev</i>	0.017	0.012
<i>l.sepreg*findev</i>	0.006**	0.003
<i>l.unbundling*findev</i>	0.001	0.030
<i>gdppc</i>	0.902***	0.140
<i>urbanization</i>	0.028***	0.005
<i>countryrisk</i>	-0.001	0.001
Obs.	270	
Fisher	F(31, 238) = 2074.12***	
R <sup>2</sup>	0.99	

In fact, by ensuring a proper functioning of the industry, regulation has the effect of reducing business uncertainty, which in turn encourages the involvement of the private sector in the power sector (Andres et al., 2009). In the second chapter, we find a positive impact of the level of financial development on private participation in energy projects and argued that this is so because well-developed financial systems facilitate access to financing and risk-mitigating instruments. Hence, the positive effect of the interaction between the variable indicating the creation of an independent regulator with the variable that measures financial development reflects the positive impact of private participation on electricity generation per capita.<sup>44</sup> That is to say, the effect of the existence of an independent regulator on output is boosted by the positive effect of financial development on private participation in energy projects.

In contrast with the findings of Zhang et al. (2008), the unbundling of the generation, transmission, and distribution segments seems to have decreased generation per capita in our dataset.<sup>45</sup> This result may reflect the monopoly characteristics and important economies of scale

<sup>43</sup> In these tables, we indicate by "\*", "\*\*", and "\*\*\*" significance at the 10%, 5%, and 1% level respectively.

<sup>44</sup> More formally, the marginal effect of the variable *sepreg* on *generationpc* is positively related to the variable *findev*, a variable found in the second chapter to be positively related to *ppgen*, and the latter can be seen from Table 3.4 to be positively related to *generationpc*.

<sup>45</sup> Note that, although not statistically significant, the coefficient associated with the variable that crosses the

of the electricity industry, which can limit the effect of introducing more competition (Zhang et al., 2006). Another potential explanation is that, given the characteristics of the power sector, the sequencing of reforms, which we abstract from in this chapter, matters for implemented policies to have the expected positive impact on performance (Zhang et al., 2005). We finally note that the control variables *gdppc* and *urbanization* are both statistically significant and have the expected sign while *countryrisk* does not seem to have a direct effect on electricity output.

When the power sector performance is measured by sales per employee in the distribution segment, a proxy for labor efficiency in this segment, the estimation results, which are presented in Table 3.5 below, show that private participation, as well as the experience of a regulatory body independent from the Ministry of energy effectively spur the productivity of labor the year following these policies implementation (Gassner et al., 2009, Andres et al., 2009). In contrast, while positive, the effect of the introduction of competition is not statistically significant.

**Table 3.5** - Electricity sales per employee (*salesperemp*)  
regression parameter estimates

Variable	Coefficient	Std. error
<i>intercept</i>	23.985	18.050
<i>l.ppdist</i>	0.009*	0.006
<i>l.expreg</i>	0.092*	0.050
<i>l.competition</i>	0.860	0.847
<i>l.findev</i>	-0.944	0.750
<i>l.ppdist*findev</i>	-0.002	0.007
<i>l.expreg*findev</i>	0.087***	0.031
<i>l.competition*findev</i>	0.071	0.874
<i>gdppc</i>	-1.644	2.067
<i>urbanization</i>	-0.070	0.082
<i>countryrisk</i>	0.033	0.030
Obs.	120	
Fisher	F(23, 96) = 65.32***	
R <sup>2</sup>	0.38	

Our findings also highlight that the interaction between the experience of the independent regulatory authority and financial development significantly improves labor efficiency as shown by the positive coefficient of this interaction term. As in the previous analysis (see Table 3.4 above), it appears that allowing private participation in the distribution segment combined with better regulation and a well-developed financial sector boosts the productivity of labor. Indeed, by introducing more efficient managerial principles, the private sector helps enhancing workers'

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variables *unbundling* and *findev* has a positive sign.

efficiency in the power sector (see Chapter 2). In contrast, none of the control variables turns out to have a direct effect on labor efficiency in our data.

Turning now to the analysis of the effects of sectoral reforms and financial development on operational and technical efficiency when using the power losses in the transmission and distribution networks as a proxy for this productive efficiency, the regression results, which are displayed in Table 3.6 below, show a negative and significant coefficient for the (lagged) variable that says that private participation exists in the distribution segment. This result, which is in line with Andres et al. (2009) and Gassner et al. (2009), emphasizes that, by improving expertise and contributing to the financing of the distribution network's upgrading and modernization, the private sector significantly enhances operational and technical efficiency. However, when taking financial development into account, only the unbundling of the generation, transmission and distribution segments seems to improve the network's efficiency as shown by the negative and significant coefficient of the interaction variable *l.unbundling\*findev*.

**Table 3.6** - Transmission and distribution losses (*distlosses*)  
regression parameter estimates

Variable	Coefficient	Std. error
<i>intercept</i>	-1.190	3.798
<i>l.ppdist</i>	-0.003**	0.001
<i>l.sepreg</i>	0.007	0.191
<i>l.unbundling</i>	-0.378	0.239
<i>l.findev</i>	0.113	0.156
<i>l.ppdist*findev</i>	-0.001	0.001
<i>l.sepreg*findev</i>	0.086	0.224
<i>l.unbundling*findev</i>	-0.344**	0.151
<i>gdppc</i>	-1.313*	0.665
<i>urbanization</i>	0.117**	0.052
<i>countryrisk</i>	0.001	0.009
Obs.	139	
Fisher	F(25, 113) = 48.16***	
R <sup>2</sup>	0.86	

Unlike Sen and Jasmab (2010), our analysis provides evidence that the disentanglement of the generation, transmission, and distribution segments of the electricity sector significantly improves technical efficiency only when backed by a developed financial system (see Table 3.6). Indeed, our findings suggest that unbundling the power sector's segments to introduce more competition effectively spurs the networks' efficiency when countries' banking sector and stock markets are developed enough to provide long-term financing, in particular, for power supply improvement (see Chapter 2 and Zhang et al., 2002). This effect may also be exacerbated by

significant impact of private participation. Similarly, we find that the coefficients of the control variables GDP per capita (a proxy for a country's overall level of economic development) and urbanization (a proxy for the density of the population in urban areas and hence for possible congestion) are significant.

The last dimension of the power sector performance considered in this analysis is access to electricity as measured by the electrification rate. The estimation results reported in Table 3.7 above yield a positive and significant coefficient associated with the variable that represents the introduction of private participation in the distribution segment, *ppdist*. This result therefore confirms that opening the distribution segment to the private sector effectively improves access to power, essentially through better managerial expertise and financing than the status quo (Basilio, 2010). Likewise, regression results highlight that the experience of the autonomous regulatory authority in place, *expreg*, fosters access to electricity which suggests that consumer protection and electrification targets imposed by experienced regulators have indeed been effective in contributing to improving electricity coverage.

**Table 3.7** - Electrification (*electrification*)  
regression parameter estimates

Variable	Coefficient	Std. error
<i>intercept</i>	4.140***	0.704
<i>ppdist</i>	0.001**	0.000
<i>expreg</i>	0.010***	0.003
<i>competition</i>	-0.052**	0.023
<i>findev</i>	0.062*	0.032
<i>ppdist*findev</i>	-0.000	0.000
<i>expreg*findev</i>	-0.003	0.002
<i>competition*findev</i>	-0.042	0.042
<i>gdppc</i>	0.021	0.092
<i>urbanization</i>	0.001	0.006
<i>countryrisk</i>	0.002	0.001
Obs.	103	
Fisher	F(22, 80) = 340.91***	
R <sup>2</sup>	0.98	

In contrast, and somewhat surprisingly, our findings suggest that competition has an adverse effect on countries' electrification rate. A possible explanation for this result is that, even though some degree of competition in distribution is desirable to promote power supply, the effect of competition may be limited by the natural monopoly characteristics and important economies of scale of the sector (Zhang et al., 2006). An alternative explanation is that entry tends to occur in economically profitable urban areas, which implies that some typically rural

areas might be left with no power supply. Finally, although its individual effect is positive and significant, financial development was found not to have any cross effect with the variables of sectoral reforms. The control variables GDP per capita and urbanization turn out not to be significant determinants of access to electricity.

What do the results say about the impact of the power sector reform on the industry performance and the way the various reform policies interact with the level of financial development? As discussed earlier, one way to tackle this question is to examine whether some empirical evidence can be extracted from the analysis on the validity of the various hypotheses stated in Table 3.1. Table 3.8 below summarizes our findings. This table gives the outcome of the test of each of the eight hypotheses,  $H_I$  and  $\bar{H}_I$ ,  $I=1,2,\dots,4$ . Its second column indicates whether or not each of these hypotheses has not been rejected in the data with a "Yes" or a "No" and, in the case where it has not been rejected, gives the variables involved in the relationship(s) that allowed us to conclude on the no-rejection.<sup>46</sup>

Examining the validity of the four hypotheses concerning the individual sectoral reform policy effects,  $H_1$  through  $H_4$ , on performance, we see that each of them is validated when at least one of our four performance indicators is used, thereby suggesting that all segments of the electricity industry have globally benefited from the implemented reforms. Openness to the private sector and the establishment of an autonomous regulator seem to be the most effective reforms. Indeed, both measures were found to significantly help improving electricity output, labor productivity and access, and lowering distribution losses. In contrast, the disentanglement of the generation, transmission and distribution segments meant to introduce more competition in generation and distribution appears to be less successful as we find no direct effect on the performance indicators considered in this study. As pointed out earlier, this result may be explained by the natural monopoly characteristics of the power sector and targeted entry.

Interestingly, our empirical results show that financial development reinforces the effect of unbundling on the network's technical efficiency, which allows us not to reject  $\bar{H}_2$  (see Table 3.6). Likewise, financial development has significantly enhanced the effect of the creation of an independent regulator on power generation per capita as can be seen from Table 3.4, leading to the non-rejection of  $\bar{H}_4$ . We also find that a deeper and more liquid financial sector strengthens the effect of the existence and the experience of an autonomous regulator on labor productivity, which is also in line with  $\bar{H}_4$ . These findings therefore support, to some extent, our conjecture

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<sup>46</sup> In case of no-rejection the sign of the relationship and the table that shows it are given in parentheses.

that financial development fortifies the impact of the power sector reforms on this sector's performance.

**Table 3.8 - Hypotheses testing**

Hypothesis	Test outcome
H1	Yes <i>ppgen</i> → <i>generationpc</i> (+) (Table 3.4) <i>ppgen</i> → <i>electrification</i> (+) (Table 3.7)
$\bar{H}1$	No
H2	Yes <i>ppdist</i> → <i>distlosses</i> (-) (Table 3.6)
$\bar{H}2$	Yes <i>unbundling</i> → <i>distlosses</i> (-) (Table 3.6)
H3	Yes <i>ppdist</i> → <i>salesperemp</i> (+) (Table 3.5)
$\bar{H}3$	No
H4	Yes <i>sepreg</i> → <i>generationpc</i> (+) (Table 3.4) <i>expreg</i> → <i>salesperemp</i> (+) (Table 3.5) <i>sepreg</i> → <i>electrification</i> (+) (Table 3.7)
$\bar{H}4$	Yes <i>sepreg</i> → <i>generationpc</i> (+) (Table 3.4) <i>expreg</i> → <i>salesperemp</i> (+) (Table 3.5)

### 3.6 Conclusion

The main motivation of this chapter was to demonstrate the existence of a significant empirical link between infrastructure sectors reforms and financial development the effects of which are reflected in infrastructure sectors performance. This chapter has reported on the findings of an exploration of this issue for the case of the power sector in 42 developing countries from 1990 to 2005. We have focused on the four main components of the power sector reform conducted in these countries, namely, unbundling, competition, private participation, and regulation and examined their impact on some of this sector's performance outcomes both on their own and via their interaction with financial development resulting from financial reforms.

The logic of the empirical strategy used relied on results found in some of our previous work in the area. On the one hand, in the first chapter we find a significant positive link between

financial reforms and the level of development of financial systems in a dataset on 54 developing countries covering the 1973-2005 period. On the other hand, using a dataset on 56 developing countries that covers the 1990-2007 period, in the second chapter we provide empirical evidence on the importance of financial development for fostering private participation in energy projects financing, which is crucial to the growth and performance of the power sector. The empirical analysis conducted in the present chapter allowed us to test whether financial development strengthens the impact of the power sector reforms on this sector's performance. Putting together these findings, a conclusive test would then suggest that financial reforms have significant positive "externalities" on the power sector reforms.

Our empirical investigation through panel data regressions yields results that allow us to conclude that the power sector reforms have indeed reached some success in improving some aspects of the development of this sector. More specifically, we find that private participation in generation and distribution has led to significant improvements in the power sector performance as gauged by higher electricity output per capita, improved technical efficiency, and better electricity coverage. By contributing to the financing of power projects and introducing more efficient management practices, the private sector has enhanced the overall performance of the electricity industry. The creation of a separate regulatory agency has helped creating a better dynamic in the generation and distribution segments that boosted generation per capita, labor efficiency, and access to electricity. By ensuring a proper functioning of the power sector, including consumer protection, better regulation has significantly improved the performance of the sector indeed.

Interestingly, our empirical results provide evidence that the beneficial effects of unbundling and of the creation and the experience of an autonomous regulator have been exacerbated by the modernization of the financial systems. Following the introduction of competition and the creation of an independent regulatory authority in the electricity industry, developed financial systems have eased access to capital for operators needing to upgrade their networks in order to increase output, improve labor productivity, and lower power losses in transmission and distribution, thereby enhancing both access to and usage of electrical energy.

The econometric analysis conducted in this study will clearly gain from improving the dataset. In particular, the data improvement should include more precise sectoral reforms indicators instead of dummy variables, accounting for the sequencing of the reforms, and controlling for the characteristics of the regulatory authority. Nevertheless the analysis performed in this chapter recommends that along with reforming the power sector, policy makers in

developing countries should implement the financial reforms that would deepen most their domestic financial systems thus allowing them to recover the full benefits of these systems' positive externalities on the performance of the sector.<sup>47</sup>

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<sup>47</sup> This task is on our current research agenda.

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# Appendix 1

**Table A1.1 - Content of variables and data sources**

Variable	Content	Source
<i>liqliab</i>	Domestic banks liquid liabilities as a percentage of GDP.	The World Bank Financial Development and Structure database (2007).
<i>smc</i>	Value of stock market capitalization expressed as a percentage of GDP.	Idem.
<i>tvf</i>	Total value of stocks traded expressed as a percentage of GDP.	Idem.
<i>creditcontrols</i>	Measures the tightness of mandatory bank reserve requirements, the existence of compulsory credit allocation requirements, the presence and extent of subsidized credit schemes, and the experience of quantitative restrictions on bank credit growth. The total score is normalized to a 0-3 scale, with 0 corresponding to the highest degree of repression and 3 indicating full liberalization.	IMF Financial Reform Database (2008).
<i>intratecontrols</i>	Reflects the extent to which deposit and lending rates are market determined rather than subject to administrative ceilings (repression). The total score is normalized to a 0-3 scale, with 0 corresponding to the highest degree of repression and 3 indicating full liberalization.	Idem.
<i>entrybarriers</i>	Measures restrictions on entry into the banking sector of new domestic banks or other potential competitors such as foreign banks or non-bank financial intermediaries. The total score is normalized to a 0-3 scale, with 0 corresponding to the highest degree of repression and 3 indicating full liberalization.	Idem.

Variable	Content	Source
<i>bankingsuperv</i>	Varies according to whether Basel capital regulation and a number of characteristics of the bank supervisory system have been adopted: whether a country adopted risk-based capital adequacy ratios based on Basel I capital accord, the degree of independence of the supervisory agency, the effectiveness of on-site and off-site examinations of banks by supervisory agency, and whether all banks are subject to supervision or not. A higher score is associated with better regulation and supervision and the total score then normalized to a 0-3 scale, with 0 corresponding to the highest degree of repression and 3 indicating full liberalization.	Idem.
<i>privatization</i>	Tracks the extent to which bank assets are controlled by private owners rather than the government. In this database, the authors look at the share of banking assets controlled by state-owned banks. Thresholds of 50%, 25% and 10% for the share of banking assets controlled by state-owned banks are used to distinguish full repression and full liberalization. The total score is normalized to a 0-3 scale, with 0 corresponding to the highest degree of repression and 3 indicating full liberalization.	Idem.
<i>intlcapital</i>	Measures restrictions on international financial transactions often imposed to give the government greater control over the flow of credit within the economy as well as over the exchange rate. These restrictions include multiple exchange rates for various transactions, transactions taxes or outright restrictions on inflows and/or outflows specifically regarding financial credits. The total score is normalized to a 0-3 scale, with 0 corresponding to the highest degree of repression and 3 indicating full liberalization.	Idem.
<i>bsreforms</i>	Banking sector reforms index calculated as the sum of the six previous banking sector reforms measures.	

<i>Variable</i>	<i>Content</i>	<i>Source</i>
<i>smreforms</i>	Measures policies used by governments to either restrict or encourage the development of securities markets development: auctioning of government securities, establishment of debt and equity markets, policies to encourage the development of these markets such as tax incentives or the development of depository and settlement systems, and policies on the openness of securities markets to foreign investors. The total score is normalized to a 0-3 scale, with 0 corresponding to the highest degree of repression and 3 indicating full liberalization.	IMF Financial Reform Database (2008).
<i>finreforms</i>	Financial reforms index equal to the sum of all seven individual financial reforms measures and varies from 0 to 21, with 0 corresponding to the highest degree of repression, and the higher the value the more liberalized the financial system.	Idem.
<i>privcap</i>	Net private capital flows to GDP given by the sum of direct, portfolio, and other investment inflows and outflows registered in the balance of payments financial account.	World Bank World Development Indicators (WDI).
<i>countryrisk</i>	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 (ICRG) database.
<i>laworder</i>	Index with a "law" component assessing the strength and impartiality of the legal system and an "order" component assessing popular observance of the law. This index ranges from 0 to 6 (the higher the score, the better the legal environment).	Idem.
<i>corruption</i>	Corruption index ranging from 0 to 6 (the higher the score, the less corrupt the economic system).	Idem.
<i>burqual</i>	Institutional strength and quality of the bureaucracy index ranging from 0 to 4 (the higher the score, the better the quality).	Idem.

Variable	Content	Source
<i>gdppc</i>	Natural logarithm of GDP per capita.	ERS International Macroeconomic dataset (2008).
<i>inflation</i>	Yearly inflation rate as measured by the consumer price index reflecting the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals.	World Bank World Development Indicators (WDI).
<i>fiscalbal</i>	Cash surplus or deficit is revenue (including grants) minus expense, minus net acquisition of nonfinancial assets as a percentage of GDP.	Idem.
<i>tradeopen</i>	Trade openness indicator calculated as import plus export as a percentage of GDP.	Idem.
<i>cr</i>	The index measures four powers of secured lenders in bankruptcy; The creditor rights index aggregates the scores and varies between 0 (poor creditor rights) and 4 (strong creditor rights). The higher the score, the stronger creditors' rights.	Djankov et al. (2007)
<i>democ</i>	Institutionalized democracy, additive score that ranges from 0 to 10 (full democracy).	Polity IV database <a href="http://www.systemicpeace.org/inscr/inscr.htm">http://www.systemicpeace.org/inscr/inscr.htm</a>

**Table A1.2 - Summary statistics**

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
<i>findev</i>	695	-4.87e-10	1.454	-1.334	10.600
<i>bsdev</i>	1342	0.360	0.2183	0.045	1.323
<i>smdev</i>	776	-1.94e-09	1.297	-0.775	11.590
<i>finreforms</i>	1645	8.090	5.660	0	21
<i>bsreforms</i>	1645	7.114	4.970	0	18
<i>smreforms</i>	1645	0.973	0.924	0	3
<i>privcap</i>	1062	0.022	0.032	-0.108	0.341
<i>countryrisk</i>	1009	60.412	10.591	25.375	81.867
<i>laworder</i>	1139	2.940	1.192	0	6
<i>corruption</i>	1139	2.751	1.030	0	6
<i>burqual</i>	1115	1.885	0.954	0	6
<i>gdppc</i>	1654	6.942	1.054	4.628	9.013
<i>inflation</i>	1544	55.418	408.846	-9.8	11749.6
<i>fiscalbal</i>	431	-2.118	3.313	-34.24	13.51
<i>tradeopen</i>	1591	0.562	.311	0.004	2.204
<i>cr</i>	1480	1.739	1.182	0	4
<i>democ</i>	1639	2.240	12.560	-88	10

**Table A1.3** - Correlation coefficients

	<i>findev</i>	<i>bsdev</i>	<i>smdev</i>
<i>finreforms</i>	0.260	0.208	0.298
<i>bsreforms</i>	0.245	0.182	0.286
<i>smreforms</i>	0.263	0.293	0.278
<i>privcap</i>	0.111	0.116	0.142
<i>countryrisk</i>	0.391	0.333	0.352
<i>laworder</i>	0.240	0.230	0.200
<i>corruption</i>	0.237	0.114	0.153
<i>burqual</i>	0.272	0.296	0.205
<i>gdppc</i>	0.230	0.276	0.212
<i>inflation</i>	-0.075	-0.094	-0.048
<i>fiscalbal</i>	0.150	0.044	0.161
<i>tradeopen</i>	0.512	0.509	0.509
<i>cr</i>	0.174	0.212	0.212
<i>democ</i>	0.023	0.048	0.048

## Appendix 2

**Table A2.1 - Content of variables and data sources**

Variable	Content	Source
<i>privpart</i>	Natural logarithm of total investment commitments with private participation in energy projects adjusted to consumer price index (2010 USD).	The World Bank Public-Private Infrastructure Advisory Facility (PPIAF) database.
<i>liqliab</i>	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).
<i>smt</i>	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.
<i>countryrisk</i>	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 (ICRG) database.
<i>exchrisk</i>	Exchange rate (stability) risk variable ranging from 0 to 10 (the higher the value, the lower the risk).	Idem.
<i>corruption</i>	Corruption index ranging from 0 to 6 (the higher the score, the less corrupt the economic system).	Idem.
<i>laworder</i>	Index with a "law" component assessing the strength and impartiality of the legal system and an "order" component assessing popular observance of the law. This index ranges from 0 to 6 (the higher the score, the better the legal environment).	Idem.
<i>gdp</i>	Natural logarithm of real GDP in 2000 USD (lagged).	The World Bank World Development Indicators (WDI) database.
<i>inflation</i>	Natural logarithm of inflation rate (% , lagged)	Idem.
<i>intrate</i>	Real interest rate (%).	Idem.
<i>tdlosses</i>	Electricity transmission and distribution losses (% of output).	Idem.

**Table A2.2 - Summary statistics**

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
<i>privpart</i>	410	15.17	2.03	8.66	22.36
<i>privpartgdp</i>	473	0.00	0.02	0.00	0.27
<i>findev</i>	626	0.00	1.07	-1.28	6.51
<i>liqliab</i>	889	0.04	0.24	0.05	1.30
<i>smt</i>	685	0.29	0.51	0.00	5.01
<i>gdp</i>	1003	23.81	1.69	19.65	28.53
<i>inflation</i>	940	2.29	1.44	-3.09	9.64
<i>intrate</i>	786	12.24	32.84	-91.72	572.94
<i>tdlosses</i>	949	16.92	8.98	0.00	68.95
<i>corruption</i>	868	2.58	0.90	0.00	5.00
<i>countryrisk</i>	868	64.67	8.49	33.33	82.33
<i>exchrisk</i>	878	7.81	2.18	0.00	10.00
<i>laworder</i>	868	3.20	1.12	0.00	6.00

**Table A2.3 - Correlation coefficients**

	<i>privpart</i>	<i>findev</i>	<i>liqliab</i>	<i>smt</i>	<i>gdp</i>	<i>inflation</i>	<i>intrate</i>	<i>tdlosses</i>	<i>corruption</i>	<i>countryrisk</i>	<i>exchrisk</i>	<i>laworder</i>
<i>privpart</i>	1.00											
<i>findev</i>	0.25	1.00										
<i>liqliab</i>	0.04	0.76	1.00									
<i>smt</i>	0.31	0.76	0.15	1.00								
<i>gdp</i>	0.56	0.41	0.16	0.43	1.00							
<i>inflation</i>	0.12	-0.26	-0.35	0.01	0.05	1.00						
<i>intrate</i>	0.25	-0.12	-0.13	-0.06	-0.10	-0.10	1.00					
<i>tdlosses</i>	-0.08	-0.18	-0.25	0.03	-0.26	0.10	-0.06	1.00				
<i>corruption</i>	0.03	-0.09	-0.03	-0.07	0.01	0.20	-0.15	-0.20	1.00			
<i>countryrisk</i>	0.01	0.20	0.40	-0.01	0.27	-0.23	-0.20	-0.31	0.18	1.00		
<i>exchrisk</i>	-0.28	0.11	0.19	0.04	0.08	-0.28	-0.21	0.00	-0.18	0.62	1.00	
<i>laworder</i>	0.11	0.20	0.18	0.16	0.06	-0.08	-0.05	-0.13	0.24	0.47	0.16	1.00

**Table A2.4 - Causal relationships**

	<i>findev</i>	<i>liqliab</i>	<i>smt</i>
<i>financial variables</i> → <i>privpart</i>	Yes	No	Yes
<i>privpart</i> → <i>financial variables</i>	Yes	Yes	Yes

**Table A2.5 - Hausman tests: Fixed vs. Random effects**

	<i>H</i>	Prob > <i>H</i>
Model 1	10.53	0.31
Model 2	12.29	0.27

## Appendix 3

**Table A3.1 - Content of variables and data sources**

Variable	Content	Source
<i>generationpc</i>	Net electricity generation per capita (billion Kwh).	Energy Information Agency (EIA).
<i>salesperemp</i>	Electricity sold per employee (MWh).	The World Bank Electricity Benchmarking database (2007).
<i>distlosses</i>	Annual electricity distribution losses as a % of net generation.	Energy Information Agency (EIA).
<i>electrification</i>	Electrification rate defined as the population with access to electricity as a share of the total population (%).	The World Bank Electricity Benchmarking database (2007).
<i>ppgen</i>	Private participation in generation indicator: dummy variable that takes the value 1 if there is any private participation in electricity generation and 0 otherwise.	ESMAP report (2007); various reports and websites (see references).
<i>ppdist</i>	Private participation in distribution indicator: private sector participation as a share of the number of connections.	Idem.
<i>sepreg</i>	Dummy variable that takes on the value 1 if there exists a regulatory agency that regulates energy and is separated from the energy ministry and 0 otherwise.	Cubbin and Stern (2006); The World Bank Electricity Regulation database, and various websites (see references).
<i>regexp</i>	Regulatory authority's experience indicator calculated as the number of years since its creation.	Idem.
<i>unbundling</i>	Dummy variable that takes the value 1 when generation, transmission and distribution segments are separated and 0 otherwise.	ESMAP report (2007); various reports and websites (see references).
<i>competition</i>	Dummy variable that takes the value 1 when a wholesale market where generators can compete to conclude supply contracts with distributors or large users exists and 0 otherwise.	ESMAP report (2007); Zhang et al. (2005); various reports and websites (see references).
<i>liqliab</i>	Domestic banks liquid liabilities as a share of GDPPC: measures the absolute size of the banking sector.	Idem.
<i>smc</i>	Value of stock market capitalization expressed as a percentage of GDPPC.	Idem.
<i>tv</i>	Total value of stocks traded expressed as a percentage of GDPPC.	Idem.
<i>findev</i>	First principal component of <i>liqliab</i> , <i>smc</i> , and <i>tv</i> .	Computed.
<i>countryrisk</i>	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 (ICRG) database.
<i>gdppc</i>	GDP per capita in 2005 USD.	ERS International Macroeconomic dataset (2008).
<i>urbanization</i>	Population living in urban areas as a share of the total population.	The World Bank World Development Indicators (WDI) database.
<i>population</i>	Total population.	Idem.

**Table A3.2 - Summary statistics**

Variable	Obs.	Mean	Std. Dev.	Min.	Max.	Median
<i>generationpc</i>	672	1335.81	1458.65	65.88	10039.84	861.04
<i>salesperemp</i>	209	2057.83	1459.61	101	9248	1846
<i>distlosses</i>	672	0.15	0.08	0.00	0.47	0.13
<i>electrification</i>	143	80	15.64	45.09	97.51	83.66
<i>ppgen</i>	512	0.50	0.50	0.00	1.00	0.00
<i>ppdist</i>	227	49.68	45.55	0.00	100	45.91
<i>sepreg</i>	624	0.37	0.48	0.00	1.00	0.00
<i>expreg*</i>	624	2.23	4.44	0.00	25.0	0.00
<i>unbundling</i>	576	0.28	0.45	0.00	1.00	0.00
<i>competition</i>	448	0.29	0.45	0.00	1.00	0.00
<i>findev</i>	419	-0.00	1.77	-2.61	8.85	-0.53
<i>gdppc</i>	672	2740.59	1928.06	35.75	11082.43	2484.97
<i>urbanization</i>	672	52.82	18.72	15.10	92.30	52.70
<i>countryrisk</i>	576	64.69	8.68	35.00	82.00	66.00

\*The maximum value of this variable corresponds to Costa Rica, which has created a multi-sector regulatory agency (ARESEP) in 1980.

**Table A3.3 - Correlation coefficients between the sectoral reforms and performance variables**

	<i>ppgen</i>	<i>ppdist</i>	<i>sepreg</i>	<i>expreg</i>	<i>unbundling</i>	<i>competition</i>	<i>findev</i>
<i>generationpc</i>	0.14	-0.24	0.08	0.14	-0.09	0.11	0.22
<i>salesperemp</i>	0.33	0.23	0.41	0.55	0.41	0.24	0.52
<i>distlosses</i>	-0.16	-0.29	0.08	-0.10	0.15	0.08	-0.33
<i>electrification</i>	0.02	0.01	0.34	0.47	0.01	0.12	0.08