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FOREIGN DIRECT INVESTMENT IN INFRASTRUCTURE IN DEVELOPING COUNTRIES: DOES REGULATION MAKE A DIFFERENCE?

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INTRODUCTION

In developing countries, an essential requirement for economic growth and sustainable development is the provision of efficient, reliable and affordable infrastructure services, such as water and sanitation, power, transport and telecommunications. The availability of efficient infrastructure services is an important determinant of the pace of market development and output growth, and in addition, access to affordable infrastructure services for consumption purposes serves to improve household welfare, particularly among the poor. In most countries, however, the potential contribution of infrastructure to economic growth and poverty reduction has not been fully realised and existing infrastructure stock and services fall far short of requirements.

Traditionally, infrastructure was the exclusive province of the public sector, with large, state-owned enterprises (SOEs) being responsible for investment and service delivery. Typically, the SOE sector was a costly and inefficient provider of infrastructure in most developing countries. Since the mid-1980s, however, governments around the world have pursued policies to involve the private sector in the delivery and financing of infrastructure services. Encouraged by international organisations such as the World Bank, privatisation has been a major component of the economic reform programmes pursued by many developing countries over the past two decades (Parker and Kirkpatrick, 2004). Privatisation was predicted to promote more efficient operations, reduce the financial burden on government budgets expand service delivery, and increase the level of foreign and domestic private investment (World Bank, 1995). Much of the early privatisation activity was concentrated in the manufacturing sector, but in recent years the private sector has become increasingly involved in the financing and delivery of infrastructure services. A large number of developing countries have introduced private participation into their infrastructure industries, and by the end of 2001, developing countries had received over $755 million in private investment flows in nearly 2500 infrastructure projects (World Bank, 2003a).

Utilities such as water supply, gas, electricity and telecommunications and certain modes of transport such as rail, all include natural monopoly characteristics arising from pervasive

economies of scale and scope. These characteristics mean that competition is unlikely to develop, or if it develops, it will be uneconomic because of the duplication of assets. Although technological advances, notably in telecommunications, have whittled away some of the natural monopoly characteristics in utilities, permitting economic competition in certain areas of service delivery, nevertheless each of the utilities retains some natural monopoly features. As a consequence, privatisation of these industries, in whole or in part, risks the introduction of private-sector monopolies that will exploit their economic power in the market place, leading to supernormal profits (high 'producer surplus') and reduced consumer welfare (a lower 'consumer surplus'). Consumers may suffer from no or a limited choice of goods and services and face monopoly prices.

To prevent this result, governments need to develop strong regulatory capabilities so that they can police the revenues and costs of production of the privatised utility firms and protect consumers from monopoly exploitation. At the same time, there needs to be commitment on the part of government to the regulatory rules to establish credibility on the part of the investors that the regulatory rules will bring about the intended outcome. Where regulatory credibility is weak or absent, private investment decisions will be adversely affected.

This paper examines the relationship between the quality of the regulatory framework and foreign direct investment in infrastructure in developing countries. Using data for the period 1990 to 2002, we test the impact of regulation on the inflow of foreign direct investment (FDI) to infrastructure projects in middle and lower income economies. There are seven sections to the paper. The next section reviews the recent growth in private participation in infrastructure in developing countries and describes the sectoral and geographical distribution of private investment in the infrastructure sector. Section 3 reviews the recent literature on institutional development and economic performance, focusing on the empirical evidence on the effect of institutional governance on the location of foreign direct investment. Section 4 considers the role of infrastructure regulation in developing countries, identifies the characteristics of 'good' regulation, and discusses the difficulties that are encountered in establishing a regulatory regime that is credible to private market actors, in particular to potential investors in infrastructure projects. In section 5 we address the central question that this paper is concerned with, namely has the quality of regulation influenced the inflow of foreign direct investment to the infrastructure sector in developing countries? The dependent and independent variables selected for inclusion in the empirical

testing are described, and the data sources are detailed. The econometric model used for testing the relationship between regulation and FDI is also specified in this section. Section 6 presents the estimation results. The final section provides a summary and conclusions.

FOREIGN DIRECT INVESTMENT IN INFRASTRUCTURE IN DEVELOPING COUNTRIES

Direct foreign investment has expanded steadily over the past three decades. The growth in FDI accelerated in the 1990s, rising to $331 billion in 1995 and $1.3 trillion in 2000 (UNCTAD, 2002). As a result, developing countries experienced a sharp increase in the average ratio of FDI to total investment during the 1990s. A principal feature of the growth in FDI has been the rise in foreign investment in the service sector, which is now the dominant sector in global FDI. For developing countries, FDI in services increased at an annual rate of 28 per cent over the period 1988 to 1999, and by 1999 accounted for 37 per cent of total foreign investment inflows.

A significant part of the increase in foreign investment in the services sector has been the growth in private capital flows for infrastructure, in response to the general trend towards privatisation of infrastructure in developing countries. In contrast, there was a sharp decline in donor support for infrastructure projects during the 1990s, with aggregate flows of official development assistance for the infrastructure sector halved during the course of the decade (Willoughby, 2002). Private sector participation in infrastructure projects in developing countries has risen dramatically since 1990 and annual investment commitments reached a peak of $128 billion in 1997. According to the World Bank's Private Participation in Infrastructure (PPI) database, 26 countries awarded 72 infrastructure projects with private participation in 1984-89, attracting almost $19billion in investment commitments. In the 1990s, 132 low- and middle- income countries pursued private participation in infrastructure – 57 of them in three or all four of the sectors covered in the database (transport, energy, telecommunications, and water and sewerage). In 1990-2001 developing countries transferred to the private sector the operating risk for almost 2,500 infrastructure projects, attracting investment commitments of more than $750billion.

Private infrastructure projects have taken a number of forms, involving varying degrees of investment risk. Management and lease contracts involve a private entity takes over the management of the state owned enterprise for a given period although the facility continues to be owned by the public sector. Under a concession agreement a private entity takes over

the management of a SOE for a given period during which it assumes significant investment risk. The ownership of the facility reverts back to the public sector at the end of the concession period. With greenfield projects a private entity or a public-private joint venture builds and operates a new facility for the period specified in the project contract. The facility may return to the public sector at the end of the contract period, or may remain in private ownership. The fourth form of private participation in infrastructure has been divestiture where a private entity buys an equity stake in a SOE through an asset sale, public offering or mass privatisation programme. Over the period 1990-2001, divestitures accounted for 41% ($312billion) of total private participation infrastructure projects in developing countries, greenfield projects accounted for 42% and concessions for 16% (World Bank, 2003a).

Among the developing regions, Latin America and the Caribbean accounted for 48% of the cumulative investment in infrastructure. In this region private participation in infrastructure was often part of a broader sectoral reform programme, aimed at enhancing performance through private operation and competition and generating the financial resources needed to improve service coverage and quality through tariff adjustments (World Bank, 2003a, p2-3). Under this approach divestitures and concessions of existing assets predominated, accounting for 75% of the cumulative investment in private infrastructure projects in Latin America during the period. In more recent years, Latin America's dominance of investment in infrastructure has declined, from 80% in 1990 to 40% in 2001, as other regions have opened their infrastructure sector to private participation. The East Asia and Pacific region has been the second largest recipient of private investment in infrastructure. Over the period 1990-2001 it accounted for 28% of cumulative private participation in infrastructure in developing countries. In contrast to Latin America, the Asia region has focused on the creation of new assets through greenfield projects, which accounted for 61% of the investment in East Asia in 1990-2001. The Asian financial crisis of 1997-8 saw the region's share in annual investment in infrastructure decline from 40% in 1996 to 11% in 1998, before recovering to 28% in 2001.

Private participation in infrastructure in developing countries has been concentrated in the telecommunications sector which accounted for 44% of the cumulative investment in 1990-2001. Energy, which includes electricity and the transmission and distribution of natural gas, attracted the second largest share of investment, accounting for 28% of the cumulative investment in private infrastructure projects in 1990-2001. In contract, private participation

in the water and sewerage sector has been limited, accounting for 5% of cumulative investments over the period 1990-2001. The limited amount of private involvement in water utilities is likely to reflect the inherent difficulties that face privatisation in this sector, in terms of the technology of water provision and the nature of the product, transaction costs and regulatory weaknesses (Kirkpatrick, Parker and Zhang, 2004a).

GOVERNANCE AND FDI

There is an long established and extensive literature on the determinants of foreign investments flows to developing countries (Dunning, 1993; Moran, 1999). The focus of many of the early contributions to this literature was on the economic determinants of FDI inflows and showed that multinational enterprises are attracted to invest in locations that allow the enterprise to exploit its ownership specific advantages.

More recent contributions have examined the influence of institutional factors in explaining cross-country differences in foreign investment flows. Building on the insights of the new institutional economics which argues that economic development is not simply the result of amassing economic resources in the form of physical and human capital, but is also a matter of 'institutional building' so as to reduce information imperfections, maximise economic incentives and reduce transaction costs, it is increasingly recognised that differences across countries in economic conditions provide only a partial explanation of the location choices of multinational enterprises and that the quality of a country's institutional framework can have a significant impact on the perceived investment environment.

Institutions have been defined in a variety of ways. Following North's (1990, 1991) widely cited definition, the institution framework has been represented as the set of informal and formal 'rules of the game' which constrain political, economic and social interactions. From this perspective, a 'good' institution environment is one that establishes an incentive structure that reduces uncertainty and promotes efficiency, thereby contributing to stronger economic performance. Included in this institutional structure are the laws and political and social norms and conventions that are the basis for successful market production and exchange. This broad concept of institutions has been incorporated into empirical studies of FDI using a range of indicators. It is now common, for example, to include a variable to control for inter-country differences in the broad political environment (Altomonte, 2000; Morisset, 2000), although as noted by Dawson (1998), the results have been mixed. A measure of inter-country differences in corruption has also been shown in several studies to

have a significant impact on private investment (Wei, 2000; IFC, 2002). The extent of legal protection of private property and how well such laws are enforced, is an additional factor that has also been shown to have a significant effect on foreign investors' location decision.

A parallel stream of research has focused on perceptions and assessments of the quality of public institutions – especially on how well they function and what impact they have on private sector behaviour (IMF, 2003). The term 'governance' has been adopted in the literature to cover different dimensions of the quality of public institutions, including government effectiveness and efficiency. Recent empirical evidence has confirmed that cross-country differences in growth and productivity are related to differences in the quality of governance (Rodrik 2000; IMF, 2003; Jalilian, Kirkpatrick and Parker, 2003). This approach has been extended recently to consider the impact of governance on cross-country differences in FDI flows. Globerman and Shapiro (2002) use the six governance indicators estimated by Kaufmann et al (1999) to assess the impact of governance quality on both FDI inflows and outflows for a broad sample of developed and developing countries over 1995-97. The Kaufmann indices describe various aspects of the governance structures, including measures of political instability, rule of law, graft, regulatory burden, voice and political freedom, and government effectiveness, and therefore encompass many of the individual institutional variables used in earlier studies. The Kaufmann governance variables are combined with measures of physical, human and environmental capital to explain FDI flows, and the results indicate that the quality of governance infrastructure is an important determinant of both FDI inflows and outflows (Globerman and Shapiro, 2002:1908-14). The study by Stein and Daude (2001) uses the gravity model approach to test for the role played by institutional quality on FDI location in Latin American countries during the period 1997-99. A group of four alternative measures of institutional quality is combined with two other sets of variables and tested as potential determinants of DFI flows. The first consists of variables which are typically used in gravity models of trade, such as GDP, per capita income and distance between the source and host countries (Greenaway and Milner, 2002). The second group consists of variables, other than the institutional ones, which can affect the attractiveness of a country as a location for FDI, such as the level of taxes on foreign investment activities, human capital, and infrastructure quality. The results show that the governance variables are almost always statistically significant, confirming that the quality of institutions has a positive impact on FDI. The results are shown to be robust to the use of a wide range of institutional variables, to different model specifications and to different estimation techniques.

REGULATION AND FDI IN INFRASTRUCTURE IN DEVELOPING COUNTRIES

The role of economic regulation in the development process has generated considerable interest among researchers and practitioners in recent years. Economic regulation by government is associated with righting 'market failures', including ameliorating the adverse effects of private enterprise. From the 1960s to the 1980s, market failure was used to legitimise direct government involvement in productive activities in developing countries, by promoting industrialisation through import substitution, investing directly in industry and agriculture, and by extending public ownership of enterprises. Since the early 1980s, regulation policy in developing countries has shifted from the interventionist state to the current focus on the regulatory state (Majone, 1997). The regulatory state model implies leaving production to the private sector where competitive markets work well and using government regulation where significant market failure exists (World Bank, 2001).

The widespread privatisation of state owned enterprises (SOEs) in developing countries has focused attention on the need for an effective regulatory framework. The available evidence on the effects of privatisation in less developed countries suggests that, in general, privatisation has improved the economic performance of former SOEs (Parker and Kirkpatrick, 2004; Shirley and Walsh, 2001). But the evidence also suggests that privatisation, *per se*, may not be the critical factor in raising productivity and reducing production costs. More important is the introduction of effective competition and organisational or political changes (for recent reviews of the literature, see Martin and Parker, 1997; Villalonga, 2000; Megginson and Netter, 2001; Kikeri and Nellis, 2001). In the case of infrastructure industries, however, simply moving a monopoly from the public to the private sphere will not result in competitive behaviour. A key requirement for privatisation success then becomes the effectiveness of the regulatory regime in promoting competition or in controlling the anti-competitive behaviour of the dominant firms. As a result, a growing number of developing countries have introduced new, dedicated regulatory offices to supervise the activities of their privatised utilities. Most of these regulatory offices are expected to have some degree of independence from day-to-day political control, although in practice political intervention seems to occur in a number of countries (Cook et al (eds) 2004). Evidence on the impact of utilities regulation in developing countries is still limited, but studies for telecommunications and electricity confirm that privatisation brings greater benefits when it is accompanied by an effective regulatory regime (Wallsten, 2001; Zhang et al 2003a,b).

The aim of utility regulation is to establish a policy environment that sustains market incentives and investor confidence. For this to be achieved, the regulator needs to be shielded from political interference, and government needs to support a regulatory environment that is transparent, consistent and accountable (Parker, 1999).This implies that the capacity of the state to provide strong, regulatory institutions will be an important determinant of how well markets perform. In particular, this form of arm's length, independent regulation is expected to encourage private capital to invest in infrastructure utilities in the face of a potential 'hold up' problem (Hart and Moore, 1988). Privatisation requires investors to sink funds into fixed assets that are specific to the venture, so that once a network is created the balance of bargaining advantage shifts from the private-sector investor to the regulator (on behalf of the government) with implications for prices and investment (Spiller, 1996). Where the investor fears this outcome, referred to as 'hold up', investors may be deterred from committing to the investment, or may require front-end loading of returns or sovereign guarantees from the state or international agencies. In turn such guarantees reduce the net economic benefits of attracting private capital by reducing managerial incentives to control costs. Some form of independent regulation can provide reassurance to investors that prices, outputs and profits will not be politically manipulated.

The challenge of providing infrastructure regulation which establishes credibility with the private sector and at the same time ensures efficient economic performance on the part of the regulated enterprises, is not easily achieved. There is an extensive literature on the distorting effects of state regulation even when conducted by dedicated regulatory bodies (Armstrong et al 1994; Guasch and Hahn, 1999). Regulation is associated with information asymmetries. The regulator and the regulated can be expected to have different levels of information about such matters as costs, revenues and demand. The regulated company holds the information that the regulator needs to regulate optimally and the regulator must establish rules and incentive mechanisms to force and coax this information from the company. Given that it is highly unlikely that the regulator will receive all of the information required to regulate optimally to maximise social welfare, the results of regulation, in terms of outputs and prices, remain 'second best' to those of a competitive market. In other words, there tends to be a trade off between state ownership reducing the information asymmetries and hence the transaction costs of regulation and the relative incentives under state control and market transacting for agents to maximise social welfare (Shapiro and Willig, 1990; Yarrow, 1999). This leads to 'credibility' and 'commitment' considerations: *credibility* on the part of investors that the regulatory rules will bring about the intended

outcome; and *commitment* of government to the current regulatory rules, so that post-privatisation or post-concession award, the regulator does not act opportunistically to reduce the prices and profits of the private regulated businesses.

Regulatory regimes are also prone to regulatory capture, where the regulatory process becomes biased in favour of particular interest groups and notably the regulated companies. In the extreme case, the regulatory capture literature concludes that regulation *always* leads to socially sub-optimal outcomes because of 'inefficient bargaining between interest groups over potential utility rents' (Laffont, 1999; Newbery, 1999). In the Chicago tradition of regulatory capture (Stigler, 1971; Peltzman, 1976) regulators are presumed to favour producer interests because of the concentration of regulatory benefits and diffusion of regulatory costs, which enhances the power of lobbying groups as rent-seekers. What is clear is that the capability of firms to influence public policy is an important source of comparative advantage (Shaffer, 1995). Balanced against the risks of regulatory capture, however, is the possibility that regulators might develop a culture of arrogant independence, bordering on vexatious regulation. This creates some uncertainty about the desirable degree of regulatory independence. In principle three broad forms of regulation can be identified: (a) the regulatory authority is *integrated* into the normal government machinery, notably where it is a section of the ministry and controlled by the minister; (b) the *semi-independent agency*, which has some independence from the ministry but where decisions can still be over-ruled by a superior government authority; and (c) the *independent agency*, where there is no right of appeal to a superior government (political) authority, though there usually will be a right of appeal to the courts to ensure fairness and rationality in the decision-making process (in a number of jurisdictions known as an appeal on 'due process') (Smith, 1997; Von Der Fehr, 2000). The independent agency is normally favoured by western advisors, who draw from the experience of regulation in the UK and US. However, regulatory independence and an impartial judicial review of due process may not be credible in some institutional structures.

An additional constraint on establishing credible and effective infrastructure regulation in developing countries can be related to the resource constraints that exist in lower income countries. Many developing countries lack the necessary trained personnel to sustain regulatory commitment and credibility. Regulatory offices in developing countries tend to be small, under-manned for the job they face, and possibly more expensive to run in relation to GDP than in developed countries (Domah, et al 2003). Familiarity with the regulatory models

and methods of regulatory policy analysis is often limited (Kirkpatrick et al 2004b). The other main difficulties found in many developing countries relate to broader governance problems (Stern and Holder, 1999; Minogue, 2002) or the legal powers and responsibilities of regulators, including their effective independence from regulatory (including political) capture.

MODELLING REGULATION AND FDI IN INFRASTRUCTURE IN DEVELOPING COUNTRIES

The basic question we seek to address is whether regulation has influenced the flow of foreign direct investment to the infrastructure sector in developing countries. More precisely, we examine whether the perceived quality of the regulation framework has an impact on the locational choice of multinational enterprises when investing in infrastructure projects in developing countries. With the move towards the privatisation of state-owned enterprises in the utilities sector, where the market continues to have strong natural monopoly market characteristics, developing countries have been encouraged to establish regulatory bodies that are intended to operate independently of government. Economic regulation attempts to 'mimic' the economic welfare results of competition, but it can do so only in a 'second best' way because competitive markets generate superior knowledge of consumer demands and producer supply costs (Sidak and Spulber, 1997). Indeed, government regulation can introduce important economic distortions into market economies: 'regulation… is far from being a full substitute for competition, it can create systematic distortions, it generally faces a trade-off between promoting one type of efficiency at the expense of another, and it is likely to generate significant costs, in terms of both direct implementation and exacerbation of inefficiency' (Hay and Morris, 1991, pp.636-7). These difficulties in designing an effective and efficient regulatory framework acquire as additional degree of complexity in the context of developing countries where significant capacity and resource constraints often arise. The impact of infrastructure regulation on market incentives, and on investment behaviour in particular, is therefore uncertain and difficult to predict *a priori*. Where the regulatory regime is successful in establishing credibility with investors, we might expect regulation to have a benign influence on investment commitments. But where the regulatory institutions are perceived to lack independence of government and to be vulnerable to political interference, investors may be deterred from committing to large-scale, sunk cost capital investments. Our basic hypothesis, therefore, is that the quality of regulation matters for investment, and we would expect to find a positive relationship, other things being equal, between the quality of infrastructure regulation and the inflow of FDI to the infrastructure sector.

Modelling and Data

The empirical framework employed in the analysis involves the use of a single equation model for testing the relationship between FDI in infrastructure and regulation. The model regresses the FDI data for each country on a measure of regulatory institutional quality, and a set of control variables. Data on foreign (private) direct investment were obtained from the database on Private Participation in Infrastructure (PPI), made available recently by the World Bank (World Bank, 2003a).[1] The PPI database records infrastructure projects with private investment in low- and middle-income countries over the period 1984 to 2002, and includes projects in transport, energy (electricity and natural gas transport), telecommunications, and water and sewerage. The database relates to total investment in infrastructure projects with private participation, rather than private investment alone. We therefore used the information on individual projects to estimate the non-private contribution to the projects, which was then excluded from the PPI data to give private investment in infrastructure projects. Examination of the detailed project information in the database also showed that on average, about 80% of private contribution in infrastructure projects in developing countries came from foreign investors. The data on private investment was adjusted accordingly to give the estimated value of private foreign investment in infrastructure.

A large number of variables have been considered in the literature as possible determinants of inward FDI, although as Globerman and Shapiro (2002: 1905) note, surprisingly few are consistently significant across the broad set of empirical studies that have been reported. Real gross domestic product per capita is commonly included in FDI studies as a measure of the level of income and demand in the economy. In addition, the literature suggests that macroeconomic stability has a significant impact on foreign investment inflows. Here we consider three macroeconomic policy measures as determinants of foreign investment inflows to infrastructure: inflation, exchange rate and openness of the economy. The annual change in the rate of inflation is included to capture the consistency of monetary policy. The annual change in the real effective exchange rate was also included as an economic stability measure, with the expectation that greater volatility in the exchange rate acts as a disincentive to risk-averse inward investment. The third economic policy variable included in our analysis is the average tax burden, which we expect*, ceteris paribus*, to have a negative impact on FDI.

A second set of control variables is intended to capture those structural characteristics of the host economy which may attract FDI. Trade openness, measured as the ratio of imports and exports to GDP, has been used extensively in empirical research on economic development, where it is typically found to be positively related to economic growth (Sachs and Warner, 1995). The relationship between FDI and openness, however, is more complex. To the extent that trade openness reflects the economy's commitment to the freer international movement of goods and services, it can be expected to encourage foreign investment. On the other hand, trade protection has been widely used to provide foreign (and domestic) investors with protection from international competition, and to the extent that the trade openness variable reflects a policy of market liberalisation, may have a negative impact, at the margin, on the FDI location decision. A country's level of financial development has also been shown to have a significant influence on the rate and pattern of economic development (Jalilain and Kirkpatrick, 2004). Where the domestic financial and capital markets are relatively underdeveloped the capacity for local financing of large scale private investments will be constrained. We might expect, therefore, to find a relatively greater use of foreign investment, other things being equal, in economies where the financial infrastructure is at an early stage of development. Labour force characteristics have been widely used as explanatory variables in empirical studies of FDI, with a range of different measures have been used in the literature, including, wage rates, skills level, and educational achievement. The hypotheses tested have varied, and on occasion, been competing. In the earlier literature, low wage, unskilled labour was seen as being attractive to FDI, particularly to export-oriented, labour intensive assembly activities. More recent literature has stressed the importance of a skilled and educated labour force for employment in technologically advanced and flexible production processes. Not surprisingly, the labour force variable is often either statistically insignificant or appears with the 'wrong' sign in regression equations (Altomonte, 2000; Stein and Daude, 2001). Two measure of human capital are used in the present study, namely, life expectancy and secondary school enrolment.

The final control variable used in our analysis relates to the quality of the infrastructure stock in the sample countries. The investment decision is expected to be influenced by the need for additional infrastructure provision if the Millennium Developemnt Goal of poverty reduction is to be achieved (Leipziger et al, 2003; Fay and Yepes, 2003). We expect, therefore, that countries with greater infrastructure needs will be more attractive to foreign

investment in infrastructure. We use two measures of the level of infrastructure provision: telephone lines per 1000 population and electricity generation per capita.

The focus of our research is on the effect that a regulation institutional framework may have on foreign investors' decision to commit resources to infrastructure projects in developing countries. Two variables are used as measures of the quality of the regulatory environment for the infrastructure sector. The first is taken from the set of governance-related variables estimated by Kaufmann, Kraay and Mastruzzi (2003). These indices (which we refer to as Kaufmann's indices in the rest of the paper), describe six aspects of the governance structures for a broad cross-section of countries: voice and accountability, political instability, regulatory quality, rule of law, control of corruption and government effectiveness. These indicators are estimated based on several hundred individual variables measuring perceptions of governance, drawn from 25 separate data sources constructed by 18 different organizations. The indicators are normalised, with higher values denoting better governance. Of the six measures, the index of government effectiveness is used in our analysis as a proxy of the regulatory environment of the infrastructure sector. This index is described by Kaufmann, Kraay and Mastruzzi (2003) as being based on 'perceptions of the quality of public provision, quality of bureaucracy, competence of civil servants and their independence from political pressure, and the credibility of government decisions.[2] A limitation of this measure is that it relates to regulatory effectiveness at the level of the economy as a whole, rather than the infrastructure sector.

In the light of this limitation of the Kaufmann measure of regulation quality, we constructed a second measure in the form of a dummy variable to indicate whether independent regulators were established in the telecommunications and electric power sectors. According to the PPI database, almost three-quarters of the private investment in infrastructure in developing countries during the 1990s was undertaken in these two sectors. This dummy allows us therefore, to examine whether the existence of independent regulators has affected private investors' confidence and decision to invest in the infrastructure sector. Information on the existence of independent regulators in the electric power sector came from World Energy Council and Energy Information Administration (Zhang, et al. 2003a), and that on the telecom sector was obtained from International Telecommunications Union (ITU). The dummy takes a value of 1 if there are independent regulators in both of the sectors. While this dummy has the advantage of relating directly to the institutional structure for utility regulation in the sample countries, the data are based on the

organisational independence of the regulatory bodies, rather than their actual autonomy from government interference.

In addition to regulatory quality, other broader aspects of governance and institutional development can affect the level of FDI in infrastructure. We constructed, therefore, the first principlal component of Kaufmann's indices to capture the quality of governance infrastructure in general.

Table 1 gives a description of the variables used in the analysis. The correlation matrix for the independent variables is provided in table 2.

Table 1. Variables, Definitions and Sources

Variable	Description	Sources
PPI	Private foreign investment in infrastructure	World Bank PPI database
GDPP	GDP per capita	World Bank Development Indicators
INFLAT	Annual change of inflation rate	World Bank Development Indicators
TAX	Tax revenue/ GDP	World Bank Development Indicators
OPEN	Export and import as % of GDP	World Bank Development Indicators
LIFE	Life expectancy	World Bank Development Indicators
EXCHANGE	Annual change of real effect exchange rate	World Bank Development Indicators; IMF
CREDIT	Domestic credit to private sector/GDP	World Bank Development Indicators
KAUF	First principal component of Kaufmann's governance indicators	Kaufmann, Kraay and Mastruzzi (2003)
GVTEFF	Kaufmann's index of government effectiveness	Kaufmann, Kraay and Mastruzzi (2003)
REG-DUM	Dummy of independent regulators	Zhang, et al. (2003a); ITU
TEL	Telephone mainlines per 1000 people	World Bank Development Indicators
ELE	Electricity generation per capita	World Bank Development Indicators

Table 2. Correlation between the Variables

	LGDPP1	INFLAT	TAX	OPEN	LIFE	EXCHANGE	CREDIT	GVTEFF	KAUF	REG-DUM	TEL	ELE
LGDPP1	1.00											
INFLAT	-0.007	1.00										
TAX	0.36	-0.069	1.00									
OPEN	0.23	-0.022	.29	1.00								
LLIFE	.67	.059	0.144	0.20	1.00							
EXCHANGE	0.02	0.36	0.028	-0.06	0.010	1.00						
CREDIT	0.31	-0.11	-0.018	0.33	0.25	-0.03	1.00					
GVTEFF	0.54	-0.062	0.25	0.26	0.47	-0.08	0.58	1.00				
KAUF	0.65	-0.07	0.36	0.27	0.53	-0.065	0.44	0.87	1.00			
REG-DUM	0.26	-0.08	-0.12	-0.23	0.16	-0.07	-0.02	-0.03	0.05	1.00		
TEL	0.67	0.003	0.56	0.39	0.56	-0.01	0.10	0.45	0.54	0.07	1.00	
ELE	0.54	0.024	0.49	0.33	0.40	0.015	0.12	0.30	0.41	-0.046	0.71	1.00

The model is specified such that PPI is measured in logarithms, with the GDP coefficient measuring the income elasticity of private investment in infrastructure. The life expectancy variable also takes the logarithms form and the other controls are in the form of percentage. Although the wealth of a country is an important factor in determining the location of FDI, there is argument that countries with high income are more attractive to FDI. The income variable was lagged for one year, therefore, to reduce the potential for bias and also to allow for adjustment lags. By the same token, the variables of openness, inflation, life expectancy, education, and the real exchange rate were all lagged.

The model is specified as follows.

$$\ln(PPI) = \beta_0 + X_{it-1}\beta_i + REG_{it}(GOV_{it})\beta_r + e_{it},$$

where *REG (GOV)* refers to the regulation and governance variables, and *X* represents the control variables. Data from 67 low- and middle-income countries for the period 1990-2002 were used in the estimation of PPI.

Panel data estimation methods were employed and models of both fixed and random effects were tested. However, in all the cases the Hausman statistics supported the fixed-effect specification. This means that the error term in the model can be decomposed into the unit-specific residual that differs between units but remains constant for any particular unit and the remainder of the disturbance.

RESULTS

Tables 3 and 4 present the results. In Table 3 we report the results separately for each of the three measures of regulation quality, namely, the Kaufmann principal components index, the Kaufmann government effectiveness index, and the utility regulation dummy variable, combined with the same set of control variables (equations 1-3). We also tested for the combined effect of utility regulation and broader governance, by combining the Kaufmann principal component variable and the utility regulation variable in the same equation (equation 4). Table 4 reports the same set of equations, with the addition of the quality of physical infrastructure variables included in the regressions.

Table 3 Estimation Results for FDI in Infrastructure

	(1)	(2)	(3)	(4)
Ln GDP per capita (lagged)	2.290 (2.490)**	2.453 (2.661)***	2.715 (2.938)***	2.426 (2.622)***
Annual change of inflation (lagged)	0.0002 (1.207)	0.0002 (1.004)	0.0003 (1.280)	0.0003 (1.267)
Tax burden (lagged)	-0.031 (0.726)	-0.031 (0.712)	-0.014 (0.338)	-0.030 (0.698)
Export and import/GDP (lagged)	-0.014 (1.194)	-0.012 (0.973)	-0.012 (0.969)	-0.013 (1.084)
Ln (life expectancy) lagged	-5.133 (2.064)**	-5.196 (2.076)**	-5.260 (2.110)**	-5.096 (2.051)**
Annual change of real effect exchange rate (lagged)	-0.002 (2.491)**	-0.002 (2.664)***	-0.002 (2.606)***	-0.002 (2.402)**
Domestic credit to private sector/GDP	-0.017 (2.212)**	-0.017 (2.144)**	-0.017 (2.129)**	-0.017 (2.236)**
First principal component of Kaufmann	1.082 (2.730)***			1.014 (2.539)**
Government effectiveness index		0.736 (1.735)*		
Regulation dummy			0.494 (1.759)*	0.359 (1.254)
Constant	12.149 (1.043)	11.123 (0.950)	8.996 (0.768)	10.862 (0.930)
D-W d Statistics	1.9122	1.9109	1.909	1.9122
Adjusted R SQ	0.5078	0.5018	0.4992	0.5085
No. of Obs.	453	453	458	453

For the key to the independent variables see Table 1

t-statistics in parentheses.

*, **, *** indicate that the coefficient is significant at the 10%, 5% and 15 levels, respectively

Table 4. Estimation Results with the Infrastructure Quality Variables

	(5)	(6)	(7)	(8)
Ln GDP per capita (lagged)	3.244 (3.411)***	3.421 (3.594)***	3.636 (3.808)***	3.365 (3.521)***
Annual change of inflation (lagged)	0.0003 (1.467)	0.0003 (1.272)	0.0003 (1.561)	0.0003 (1.522)
Tax burden (lagged)	-0.025 (0.591)	-0.023 (0.536)	0.006 (0.139)	-0.024 (0.565)
Export and import/GDP (lagged)	-0.011 (0.957)	-0.009 (0.727)	-0.009 (0.762)	-0.010 (0.854)
Ln (life expectancy) lagged	-4.520 (1.822)*	-4.593 (1.842)*	-4.785 (1.926)*	-4.491 (1.811)*
Annual change of real effect exchange rate (lagged)	-0.002 (2.527)**	-0.002 (2.690)***	-0.002 (2.637)***	-0.002 (2.441)**
Domestic credit to private sector/GDP	-0.018 (2.290)**	-0.018 (2.253)**	-0.017 (2.224)**	-0.018 (2.3129)**
First principal component of Kaufmann	1.054 (2.660)***			0.990 (2.478)**
Government effectiveness index		0.797 (1.888)*		
Regulation dummy			0.464 (1.671)*	0.339 (1.201)
Telephone lines per 1000 people	-0.224 (0.713)	-0.175 (0.557)	-0.096 (0.309)	-0.221 (0.705)
Electricity gene. Per capita	-0.093 (3.025)***	-0.099 (3.241)***	-0.100 (3.259)***	-0.092 (3.006)***
Constant	4.205 (0.356)	3.160 (0.266)	1.829 (0.154)	3.052 (0.257)
D-W d Statistics	1.91463	1.9136	1.9124	1.9146
Adjusted R SQ	0.5206	0.516	0.513	0.521
No. of Obs.	453	453	458	453

Turning first to the results for the control variables, we note that in most cases the variables display the correct sign. FDI in infrastructure is positively related to the economy's level of development as proxied by income per capita and is always statistically significant. The attractiveness of an economy to FDI varies inversely with the level of taxation and with instability in the real exchange, although only the latter variable achieves statistical significance. The proxy for human capital is negatively related to FDI, and is statistically significant. The negative sign is difficult to interpret and contrary to expectations, although as noted earlier, it is not uncommon for the labour force variable to display the 'wrong' sign or to be insignificant in other studies of the determinants of FDI. The openness variable is always negatively signed, if not statistically significant, lending support to the hypothesis that FDI is attracted to markets which offer protection from competition.[3] The level of financial sector development as measured by the ratio of private sector credit to GDP is negative and statistically significant, confirming the hypothesis that foreign investment will

be greater where the capacity of the private sector to finance its investment is constrained by an underdeveloped domestic financial sector. Finally, the physical infrastructure variables (table 4) are negatively signed (and in the case of electricity supply statistically significant), confirming that FDI in infrastructure is attracted, other things being equal, to countries where the need for additional infrastructure provision is greater.

We can now consider the results for the regulation variables. Each of the three regulation measures is correctly signed, confirming that FDI in infrastructure is positively influenced by the quality of the regulatory framework. The general measure of regulatory quality, proxied by the principal components measure of the Kaufmann indices is statistically significant, and confirms that the overall quality of the governance environment attracts inward FDI in infrastructure. The Kaufmann index of government effectiveness is also positive and statistically significant. The specific measure of infrastructure regulation based on the existence of an independent regulatory agency in the telecommunications and electricity sectors is also statistically significant. However, when the independent utility regulation variable and the measure for overall governance are both included in the same equation, the former becomes insignificant, although correctly signed. We are unable therefore, to detect a strong influence for independent utility regulation, independent of the quality of overall governance, which may indicate that investors in infrastructure are more likely to be influenced in their location decision by the overall governance environment than the existence of an independent utility regulatory authority.

SUMMARY AND CONCLUSIONS

The 1990s saw an unprecedented increase in private foreign investment in infrastructure projects in developing countries. Much of this investment was in the telecommunications and electricity sectors. For the private sector, infrastructure investment is associated with sizeable investor risk linked to the long term, sunk cost characteristics of infrastructure projects. For the government, the involvement of the private sector in 'natural monopolies' raises new challenges in designing regulatory structures that can control anti-competitive or monopolistic behaviour while at the same time maintaining the attractiveness of the domestic economy to potential foreign investors in the infrastructure sector.

The purpose of this paper was to assess the impact of regulatory governance on FDI in infrastructure projects in middle and low income economies. Using a dataset on private

participation in infrastructure projects in developing countries for the period 1990 to 2002 recently made available by the World Bank, we constructed an econometric model which was used to estimate the determinants of FDI in infrastructure. The determinants were grouped into control variables for economic policy and structural characteristics, and infrastructure regulation variables. The selection of control variables was motivated by existing research on FDI, and our results are consistent with the empirical evidence on the key determinants of FDI reported in the literature. Three alternative measures of regulation quality were deployed in our empirical analysis. All are positively signed and statistically significant.

We interpret these results as confirmation of the basic hypothesis that foreign investment in infrastructure responds positively to the existence of a effective regulatory framework which provides regulatory creditability to the private sector. By implication, where regulatory institutions are weak and vulnerable to 'capture' by the government (or the private sector), foreign investors may be more reluctant to make a major commitment to large scale infrastructure projects in developing countries. The main policy implication of our findings is the need to support capacity building and institutional strengthening for robust and independent regulation in developing countries.

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Notes

[1] The PPI database provides a more comprehensive coverage of infrastructure investment than the World Investment Directory published by the United Nations. It also has the advantage of being assembled on a consistent basis.

[2] The Kaufmann index of regulatory quality measures the burden on business via quantitative regulations, price regulations, price controls and other interventions in the economy, and was judged to be less suitable than government effectiveness as a proxy for the quality of infrastructure regulation.

[3] Ghura and Goodwin (2000) also report a negative (and statistically significant) relationship between FDI and openness, for sub-Saharan countries