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The Handshake: Why Do Governments and Firms Sign Private Sector Participation Deals? Evidence from the Water and Sanitation Sector in Developing Countries

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Abstract

This paper uses a new dataset, "WATSAN," of Private Sector Participation (PSP) projects for water and sanitation in developing countries to examine the determinants of the number of projects signed per country between 1990 and 2004. The new dataset improves on existing sources in particular in its coverage of projects with local investors and provides adequate data for cross-country regression analysis.

We use a negative binomial regression model to investigate the factors influencing the number of PSP projects in a sample of 60 developing countries with 460 PSP projects. The regression results provide support for the hypotheses that PSP is greater in larger markets where the ability to pay is higher and where governments are fiscally constrained. We test several indicators of institutional quality and find that these are generally significant in determining the number of projects signed per country. Measures of the protection of property rights and the quality of the bureaucracy emerge as the most important institutions that encourage PSP. Rule of law and the control of corruption are significant, albeit at a lower level, while the quality of contract law and political stability are not robustly significant.

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1 - Introduction

This paper focuses on the 'handshake': the decision by public and private sector agents or 'partners' to formalize a Private Sector Participation (PSP) project. We use data on the number of projects signed by country in the water sector in the 1990-2004 to analyze the determinants of deal frequency across countries. Building on the literature on the determinants of PSP investment volumes and on work done in the field of institutional economics, we test the importance of institutional, macroeconomic and 'need' characteristics of countries on their propensity to sign PSP deals using a count outcome regression model. The analysis employs data from a new database of PSP in Water and Sanitation ("WATSAN") for a sample of 460 signed PSP projects in water and sanitation in 60 developing countries. It reveals that national-level institutions are a significant determinant of the number of deals signed in each country.

In order to assess whether PSP is a viable and desirable approach to utility service provision, it is necessary to examine each stage in the project cycle, from its conception through its implementation. In this paper, we look specifically at an early stage in that process: signing the contract. This analysis contributes to an understanding of the determinants of PSP contract signature in developing countries in the water and sanitation sector. The findings may also be applied to other utility sectors.

PSP in utility sectors has attracted a great deal of interest in the academic and policy literatures. Several authors have analyzed determinants of investment volumes under PSP contracts in the telecoms and power sectors (Henisz and Zelner 2001; Henisz 2002) but no large sample study of this kind has been conducted for the water sector as sufficient data are not available. The analysis of other sectors points to the significance of judicial and political institutions in determining investment volumes. Other authors have looked at the welfare outcomes and efficiency performance of PSP projects in cross-country empirical work and through case studies (Abdala 1996; Alcázar, Abdala et al. 2000; Alcázar, Xu et al. 2000; Ménard, Clarke et al. 2000a; Ménard, Clarke et al. 2000b; Shirley, Xu et al. 2000; Birdsall and Nellis 2005). This literature also points to the importance of the institutional context. PSP performance has also been examined from the point of view of the firm. Estache and Pinglo (2004) and Sirtaine et al (2004) find that returns have not been commensurate with risks in utility PSPs.[1] Finally, interesting empirical work has recently been undertaken on the renegotiation of contracts using data from concessions in Latin America (Guasch 2004). The authors find that renegotiation is extremely common in the water sector, with 74 percent of contracts being renegotiated. On average, water projects were renegotiated within the first two years of the contract.[2]

This paper is distinct from the existing literature in its focus on the initial agreement on a PSP contract between the government and firm. This stage in the life-cycle of projects has not yet been addressed in the literature and allows us to make full use of the WATSAN dataset. Given our focus, we do not address directly the determinants of investment volumes by the private party. Similarly, the performance of PSP projects and the frequency of renegotiation are not central concerns for the issue that we examine in this paper.

The WATSAN database was assembled by the authors for the purposes of this research as existing datasets on water PSP are incomplete in important respects. In particular, WATSAN has extensive coverage of projects involving local or regional investors as well as international investors. Local

[1] Estache & Pinglo (2004) find that, for a sample of 120 PSP projects in developing countries from 1998-2002, the cost of equity (COE) exceeded the return on equity (ROE) in all years, for all sectors and all country-income groups. For the water sector, ROE were negative in two years (1999 and 2002) while COE stayed close to 10 per cent throughout the period. Sirtaine et al find that ROE rates in the water sector have been highly volatile from 1990-2001 and are lower on average over this period than in the transport, telecoms and energy sectors.

[2] Guasch's analysis of determinants of renegotiation uses a sample of 1000 concessions. For comparison, the rate of renegotiation is 54.7% for transport, 9.7% for electricity and 30% for all sectors. He finds the following factors significantly raised the incidence of renegotiation: competitive bidding, price-cap regulation, contract award based on the lowest proposed tariff, contracts containing investment requirements and when a regulatory agency was not in place. The nationality of the concessionaire, macroeconomic shocks, political cycles and levels of corruption were also found to be significant.

investors are increasingly active in the water and sanitation sector and this is therefore an important addition in our dataset compared to the next best existing resource: the World Bank PPI database.[3]

Data collection on PSP in water is usually complicated by the municipal structure of the sector. In most countries, the provision of water services is the responsibility of local government and local decision-makers may take the lead in engaging the private sector. This contrasts to the centralized structure of the power and telecoms sectors and the central-government led nature of privatization in those sectors. As a result, information on PSP projects is not necessarily collected at the national level and multiple data sources need to be used to fill in the gaps. Indeed, the nature of the sector also means that performance data is more patchy and less accurate than for other utilities.[4] As a result, the data is patchy and inconsistent across countries.

Sufficient, reliable data is not currently available on investment volumes for water sector projects to allow us to analyze the determinants of investment volumes. This is largely due to the divergence between investment commitments made by private firms and levels of investment realized. Until more reliable data becomes available on realized investment for a large sample of projects in the water sector, rigorous analysis of investment volumes is unfortunately not possible. The analysis is also restricted by the absence of reliable, comparable data on sector-level institutions. [5] Several attempts have been made to put together data on regulatory institutions in the water sector (Estache and Goicoechea 2005; Foster 2005), including by the authors of this paper, but as yet no complete dataset exists covering enough of our sample countries to pursue the analysis (Estache and Goicoechea 2005)[6]. The addition of sector-specific regulatory variables would be an interesting extension to the analysis that we intend to pursue when sufficient data have been assembled.

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[3] The World Bank's PPI (Private Participation in Infrastructure) Database is the usual reference point for information on private sector investment in infrastructure sectors. It tracks information on infrastructure projects with private investment in the energy, telecommunications, transport, and water and sewerage sectors in low- and middle-income countries. It is updated annually using commercial news databases, specialized and industry publications and internet resources. See: http://ppi.worldbank.org/. However, the World Bank recognizes that the database is not complete, especially in its coverage of the water sector where project size tends to be smaller: "The Private Participation in Infrastructure (PPI) Project Database lacks good coverage of small-scale providers of water and sewerage services because projects involving such providers usually are not reported by the sources it uses." ((Izaguirre and Hunt 2005) Another source, the Water and Sanitation Sector Public Private Partnerships Database, maintained by IWE, at the University of Cranfield (UK) contains information on 1,300 PPP contracts announced up to 2003 using a broad definition of PPP, The database contains a large number of small scale partnership contracts. The data is not publicly available. (See http://www.silsoe.cranfield.ac.uk/iwe/cws/pppdatabase/pppdatabase.htm). PSIRU, University of Greenwich (UK), also maintains a database of PSP. The database is not publicly available (See www.psiru.org)

[4] For water, international coverage data for access to "improved water supply" and "improved sanitation" is collected by the WHO-UNICEF Joint Monitoring Programme using national sources, but it is updated irregularly as and when national censuses are carried out. The WHO-UNICEF Joint Monitoring Program collects data on 'access to improved water supply' and 'access to improved sanitation' for a large sample of countries. Cross-country data is available for two years: 1990 and 2002. The figures are based on data collected in national surveys or censuses in preceding years. See http://www.wssinfo.org/en/welcome.html

[5] A distinctive characteristic of the water sector is that PSP contracts are often agreed at the local level in the absence of a national regulatory framework defined in law. Instead, a set of contracts is agreed on ad hoc basis that govern the relationship between public authorities, state enterprises and the private sector. The details of these transactions are often not recorded systematically at the national level. The regulatory framework and agency are frequently based on contractual provisions rather than primary legislation. In effect, the regulatory regime is specific to a city or region. In these cases, it would be inaccurate to describe the *country* as having an economic regulator for the water sector. This raises difficulties in establishing consistent categories for comparison as well as for data collection. Comparing water once again to other infrastructure sectors, it is evident that structural reform of the sector and the establishment of a regulatory agency is much rarer than in the telecoms and power sectors (Estache and Goicoechea 2005)

[6] The Estache and Goicoechea review is a preliminary review of PSP and regulation in three infrastructure sectors. The authors describe it as a 'rough snapshot' and the results should be taken only as an indication of the spread of reform in infrastructure. In the sample of countries covered in the, 21% of countries have an independent regulatory agency for the water sector, compared to 51% for electricity and 66% for telecoms.

The rest of the paper is structured as follows: In Section 2, we present descriptive statistics from the WATSAN database. The data show considerable volatility in numbers of projects signed over the period 1990-2004. There is a decline from a peak in 1997 to 2003 and a subsequent upturn in 2004. In terms of contract types, the data do not support the prevailing view that private investors are switching from 'high-risk' contract types like concessions to 'low-risk' management and service-type contracts.[7] On the contrary, the WATSAN data show increasing numbers of concession-type contracts. The data also document the increasing importance of non-OECD-based investors in the sector and underline the need to understand what makes local investors enter into PSP contracts, as well as the forces driving large multinational investors. In Section 3, we review the existing literature relevant to PSP determinants and develop our hypotheses on 'handshake' determinants. In Section 4, we present the data, the selection of variables and in section 5 the count outcome regression methodology. In Section 6, we present the results of the negative binomial count regression model. Section 7 concludes and suggests directions for future research.

2 – PSP in Water: Descriptive Statistics

The following stylized facts are often taken to characterize PSP in the water and sanitation sector:

- Private investment in the water sector has fallen abruptly since the Asian crisis as a result of heightened perceptions of risks on the part of foreign investors
- Private investors are no longer willing to invest in high-risk project types, like concessions and BOTs, and are turning to management contracts which imply fewer risks

In this section, we present empirical data from the WATSAN database and consider whether these statements are an accurate representation of trends.

Investment Trends

Figure 1 and table 1 show the number of contracts signed by year and by type. This shows a downturn from 2000 to 2003, followed by an upturn in 2004. 2004 is the strongest year yet in terms of number of deals signed: WATSAN reports 60 new projects in 14 countries in 2004, driven by very high levels of activity in the Chinese market.[8] This compares to the findings of the World Bank PPI Database, which records 28 projects in 9 countries were invested in 2004 in the water sector.[9]

Previous highs were recorded in 1998 and 1999. The high level of investment in these years just after the Asian Crisis may seem surprising. However, there is a lag between the firm's decision to make the investment and the signing of the contract, so the effects of the Asian Crisis may account for the downturn in 2000-2003.[10]

[7] These views were expressed, for example, in the Water Operators Roundtable session of the World Bank Water Week 1-3 March 2005 (Washington D.C.) See: http://www.worldbank.org/watsan2/waterweek/6.htm

[8] The difference between these two counts is due to (1) better coverage of China in the authors' database. Chinese projects account for 52% of the total signed in 2004; (2) the inclusion of dual desalination and power projects in the authors' database, which make up 8% of projects recorded in 2004 and (3) the cut-off project value for the World Bank database. Small projects accounts for 17% of the new contracts awarded in 2004 recorded in WATSAN.

[9] Comparing across sectors in the World Bank PPI database, water and sanitation seems to have been hit hardest by the overall downturn in foreign investment from 2000 (Izaguirre & Hunt 2005).

[10] The authors would like to thank Antonio Estache for drawing attention to this point.

Figure 1: Water and Sanitation Contracts Awarded by Year and Project Type (1991-2004)

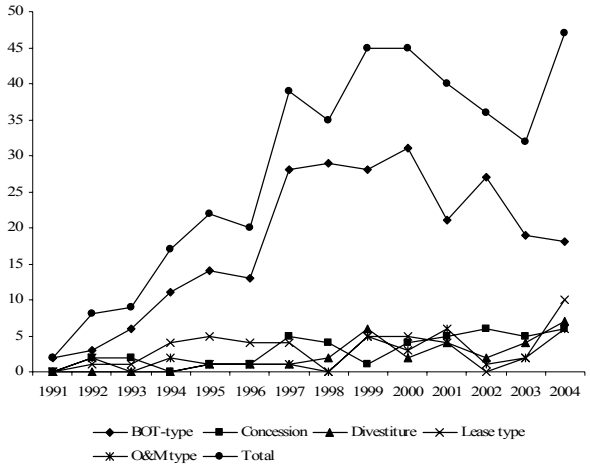


Table 1: Water and Sanitation Contracts Awarded (1991-2004) by Project Type (424 observations)

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
No. contracts signed	2	8	9	17	22	20	39	35	45	45	40	36	32	47	27
BOT-type	2	3	6	11	14	13	28	29	28	31	21	27	19	18	20
Concession	0	2	2	0	1	1	5	4	1	4	5	6	5	6	5
Divestiture	0	0	0	0	1	1	1	2	6	2	4	2	4	7	0
Lease type	0	1	1	4	5	4	4	0	5	5	4	0	2	10	2
O&M type	0	2	0	2	1	1	1	0	5	3	6	1	2	6	0

Contract Types[11]

Using a 60-country sample from the WATSAN database, we can see that the proportion of new BOT projects signed out of total projects seems to be falling back to the levels of the mid-1990s (Table 1 & Figure 2). The falling popularity of BOT projects may be explained by the experience that many countries, particularly in the Asian region, have had with this structure.[12] BOTs imply equity risk for the investor, so one explanation for the downward trend could be that private players are lo longer willing to act as

[11] In the analysis of PSP or what is often labelled public-private partnerships (PPPs), most authors rely on ownership categories – BOT, DBFO, lease etc. – that have been developed on an *ad hoc* basis mostly by law firms. As a consequence, there is some overlap between categories and some confusion regarding their analytical uses. For the purposes of this paper, we wish to base our categories on underlying economic phenomena: hence we set two proper concepts to define PSP contract types: ownership and risk. In this perspective, 'divestiture' refers to cases in which assets are owned by the private sector and all risk is private; 'concessions' refers to cases in which assets are under public ownership but the firm has responsibility for financing and implementing all capital investment (financing risk) as well as operating the asset for the period of the contract (management risk) and collecting tariffs from end users (revenue risk); BOT projects have similar characteristics to the exception that the project's client is a public agency rather than end-users (revenue risk should thus be lower); A 'lease' covers cases where the private sector has *some* responsibility for financing the investment in the maintenance of assets but key responsibilities and ownership remain in the public domain; finally, 'management contracts' are those under which the private party has no responsibility for financing capital investment, does not own the assets and only takes management risk. Thus, with the exception of management contracts, all PSP/PPP type projects are by design DBFOs (Design, Build, Finance, Operate)

[12] High tariffs paid to BOT suppliers for treated water near to or exceeding the tariffs paid for water by consumers have undermined the financial viability of public water utilities, rendering some projects unsustainable. In some cases, as in Chengdu, China, demand projections proved to be over-estimated and the use of take-or-pay contracts obliges the public utility to use treated water from the high-cost BOT supplier before using lower-cost sources (Blanc-Brude and Jensen 2004).

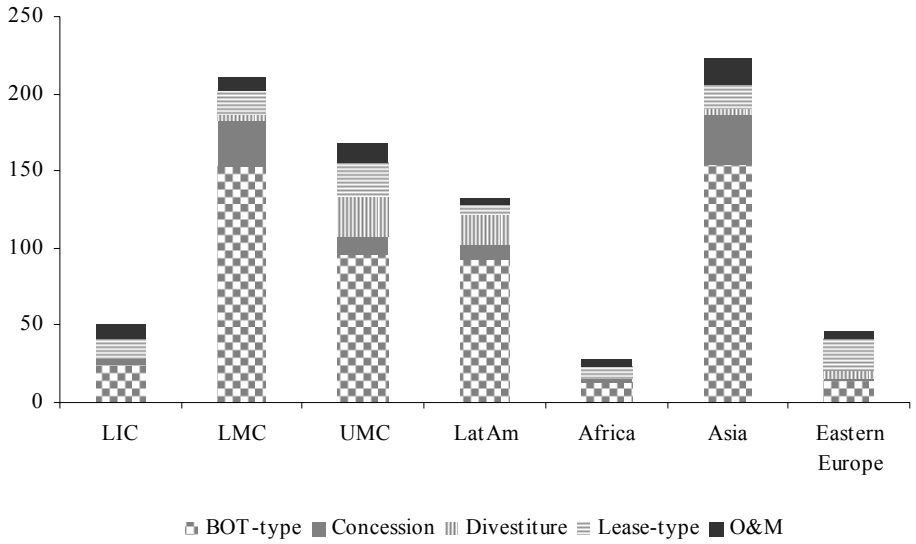
investors and finance the capital expenditure of projects. However, this view is contradicted by other evidence on concessions, which also involve financing risk. Figure 1 shows the number of new concessions signed each year has been constant or rising since 2000.

The data also show that leases and management contracts are growing in popularity as contract models, which can be explained by the increasing reluctance of private companies to take equity risk in developing regions. China, once again, in an exception to this pattern: there have been several large equity deals in recent years.[13]

Regional Trends

Looking at the regional distribution, in Figure 2, Africa has seen a lot fewer deals than Asia and Latin America. Figure 1 also shows that lower-middle-income countries have had the greatest number of PSP deals, exceeding the number of contracts in upper-middle-income countries.

Figure 2: Number of Projects by Region, Income Group and Project Type (1991-2004)



Looking at the distribution of contract types across regions and income groups, we note that there have been no divestitures among low-income countries, but divestitures are the second most frequent model in the upper-middle-income group. Concessions appear to be most important in the lower-middle-income group. Across regions, concessions have been very rare in Europe and most frequent in Asia. Divestitures are concentrated in the Latin American region, although there are also some examples in Europe. These figures are consistent with the view that investors are more willing to take equity risk (in BOTs, divestitures and concessions) in higher-income countries.

International and Local Investors

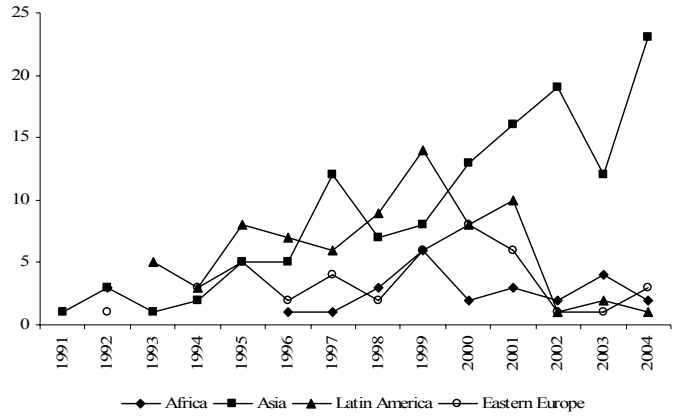
There is ample anecdotal evidence for the withdrawal of international private investors from the developing world. In 2005, for example, Suez (Ondeo), one of the world's two largest water service companies, announced that it was withdrawing from two major projects, in La Paz-El Alto (Bolivia) and Buenos Aires (Argentina). Overall, the World Bank PPI database identifies 20 projects that were either cancelled or have become 'severely distressed,' accounting for 7 percent of projects and 37 percent of investment commitments in 1990–2004 (Izaguirre and Hunt 2005:2). Our WATSAN PSP database records 28 terminated projects or 4 per cent of the total number.

However, these well publicized views of a few high profile international investors do not tell the whole story. As Figures 3 and 4 demonstrate, private water investment is booming in some parts of the world,

[13] Chinese municipalities show little or no interest in management contracts and generally require upfront capital investment by the private sector, especially foreign companies (Blanc-Brude and Jensen 2004).

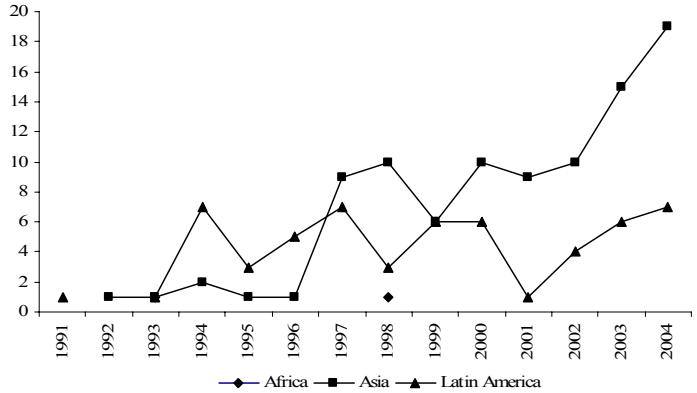
notably China (Blanc-Brude and Jensen 2004), driven by both international and local investors and elsewhere in Asia and in Latin America, regional and national companies are increasingly active. Local investors seem willing to take on financial risks that the largest international water companies are not, and are expanding rapidly into new markets.

Figure 3: Number of Projects Announced with Foreign Investors by Region and Year (1991-2004)



Using data from our 60-country sample, Figure 4 shows the increasing role of local investors in Latin America and Asia, who are taking the place of international companies, which contrasts with the established view that the water sector is dominated by a small group of European companies. In fact, projects without international involvement constitute the majority of projects in Malaysia and China and recent deals in Latin America (Chile and Peru) also point to the ascendancy of domestic companies. However, in Europe there are no projects without international involvement and there is only one project of this kind in Africa. Figure 4 also shows that most of the new investments in Latin America involve only domestic companies while the level of international involvement has collapsed. In contrast, in Asia, the growth in project numbers is due to both domestic and foreign investors. Moreover, the latter include many regional investors such as Malaysian companies investing in China.

Figure 4: Number of Projects Announced with Local Investors by Region and Year (1991-2004)



In this review of the descriptive statistics, we have noted the recovery in investment levels in 2004 and their high degree of concentration in a handful of countries. The WATSAN data also show that the common belief that investors are no longer engaging in concession-type contracts is not accurate and that local private corporations are increasingly important players in the water and sanitation markets. In the next section, we review the literature pertinent to our analysis of PSP in the water sector, before developing and testing our model of PSP with our data.

3 – Literature Review and Hypotheses: Institutions, Infrastructure and Investment

The theoretical and empirical literature points to the importance of the following factors in private infrastructure investment:

(a) Institutions, in particular the rule of law and the protection of property rights.
(b) The fiscal status of the government emerges as a likely explanatory factor in the government's decision to liberalize the sector for private investment.
(c) Low levels of coverage or poor service quality that strengthen the coalition of interests in favour of water sector reform and therefore should be associated with greater openness to PSP.

Starting with North, economists have increasingly emphasized the role of institutions in long-term development outcomes (North 1981). One strand of this literature has sought to test the relationship between institutions and macroeconomic growth, adopting an instrumental variables strategy to cope with endogeneity but treating institutions as a 'package'. Acemoglu and Johnson (2003) take this a step further and identify property rights as more significant than contracting institutions. Rigobon and Rodrik (2004) find that rule of law has a significant impact on economic performance when considering the multiple channels of interaction between institutions and development. Rule of law and property rights institutions therefore emerge as promising candidates in explaining the occurrence of PSP contracts.

The theoretical literature on contracts points to the importance of the government's 'commitment' not to renegotiate the terms of a contract or change regulatory arrangements *ex post* (Williamson 1985). The government's ability to demonstrate commitment will be affected by the country's institutions. Easterly and Serven (2003) highlight political stability, policy credibility and the existence of a sound regulatory framework as the necessary factors to lower the investor's perceived risk of expropriation. Other aspects of the institutional environment that may be important to commitment are the ability of the bureaucracy to implement policy or enforce regulation, or the quality of the legal and judicial systems and the level of corruption or sector-specific institutions.[14]

Empirical analysis of the impact of institutions raises the problem of endogeneity because private investment could be driving regulatory reform. Saleth and Dinar (2004) emphasise these feedback effects between institutions and outcomes in their work on the water sector. The water sector seems particularly susceptible to this error as PSP has frequently preceded sectoral restructuring legislation. In these circumstances, the private partner may exert a direct influence on the kind of regulatory regime created and the nature and powers of any regulatory agencies created. Indeed, the regulator may be created at the behest of the private partner as a condition for their involvement. We may not therefore maintain the assumption that causation runs exclusively from the regulatory arrangements to the level of private investment.

To deal with the problem of endogeneity, we use institutional variables that are not affected by private investment in the water sector. We choose institutional variables that are sufficiently general, such as the 'rule of law', that we can be confident that the direction of causation runs from the institutions to outcomes in the water sector. Thus we can isolate the effect of institutions on private investment.

The firm's decision to invest will be influenced by the expected risk and return associated with the project. In a portfolio of investment projects, we would expect investors to balance high risk-high return projects with low risk-low return projects. Many of the factors determining the expected risk-return outcomes will be project-specific. However, others will be associated with macroeconomic characteristics. In this research, we capture these risks using a composite measure, the ICRG Index of economic risk.

Considering PSP from the government's point of view brings a further set of considerations. The decision by a government to consider PSP in the water sector may be influenced by a number of factors. In

[14] The relationship between corruption and private investment is investigated by Everhart and Sumlinski (2001). They find that the mechanism driving the negative effect of corruption on private investment levels is due to the detrimental impact of corruption on the quality of public investment.

particular, a crisis such as a severe drought or flooding might prompt the government to consider reforms, including PSP. A financial crisis at the sector level, in which one or many water utilities were unable to service their debts, might also prompt action from the government. Secondly, loans or grants from multilateral institutions and donors directly or indirectly related to the water sector (such as an urban or rural development project) might also be associated with the decision of the government to open the sector to PSP.[15]

Secondly, a government may decide to engage in PSP as a result of a macroeconomic crisis, leading to reductions in government spending. Infrastructure investment tends to be cut more severely and sooner when governments are undertaking programs of fiscal retrenchment than other types of expenditure (Calderon, Easterly et al. 2003). In their review of the Latin American experience with economic stabilization programs, Easterly and Serven show that governments expect privatization to improve the fiscal balance by: generating revenues in the short-term through asset sales; reducing government expenditure on operating and capital expenditures; raising tax revenues, although the medium-term fiscal effects of privatization are not necessarily positive (Calderon, Easterly et al. 2003). This view is also backed up by case studies (Ménard, Clarke et al. 2000a, and others)

A further possible explanation for the level of PSP is the catch-up theory. According to this theory, rates of investment will be higher in those countries that are furthest away from the coverage frontier. Henisz and Zelner (2001) find evidence for this in their analysis of telecommunications. Coverage and service quality for water is low in most low- and lower-middle-income countries, and so we might expect the catch-up theory to operate.

However, if we consider the decision of the government to engage in PSP, we should not assume that governments choose to reform the sector directly as a result of poor coverage. In fact, it is common for the water sector to be stuck in a low-level equilibrium of low tariffs, low investment and low service quality (Savedoff, Spiller et al. 1999). Instead, we should see reform in the context of the political economy and the result of a confluence of factors strengthening the interest groups in favour of reform (Estache 2005). We would expect that governments would introduce reform when the coalition of interests in favor of reform had become sufficiently strong to overcome entrenched interests, notably private sector unions.

We use the new WATSAN PSP dataset to test the following key hypotheses emerging from the literature:

- H1: Private investors will be more likely to engage in PSP where institutions support government commitment to upholding contracts or implementing established regulatory rules. The relevant institutions are: protection of property rights; enforcement of contracts; rule of law; ability of the bureaucracy to implement policies and rules; political stability; control of corruption.
- H2: Developing country governments will engage in PSP when implementing fiscal retrenchment
- H3: Governments will be more likely to engage in PSP where demands for increasing coverage or quality are strong
- H4: Private water companies will be more likely to enter countries where household incomes are high enough to support 'willingness to pay' for water services

[15] Field research in Malaysia (Johor State) and Indonesia (Jakarta) revealed a common pattern: the water utility in each case received a loan from a donor or development bank to carry out service improvements which was linked to considering models for private sector participation in water service delivery.

4 – Data and Methodology

The WATSAN Database

The data currently available on global private investments in the water sector are barely adequate for statistical analysis of the sector. The key reference point, the World Bank PPI Database records only a subset of the contracts awarded in the sector. While it has good coverage of large projects and those involving international investors, it does not cover smaller projects or those involving domestic investors. While this might be a little impact on the observation of PSP in the power or telecom sectors, smaller projects without international involvement constitute a significant proportion of projects in the water sector and small capital investments (below US$20m) often are enough to lead to significant changes in sector performance at the municipal level.

We were prompted by the limitations of the existing data to develop a new dataset. The WATSAN PSP dataset covers both water and sanitation projects in lower and middle-income countries for the period 1990-2005. The data has been collected from multiple sources and cross-checked.[16] Data was collected on the extent and nature of private involvement, the origin of private partners, investment volumes and contract type. This information was not available for all projects. Despite the distinctions that are often drawn between types of divestitures, concessions, leases and management contracts, in practice these distinctions may often be blurred. For the purpose of this research, we classify the contracts into broad categories.[17]

A subset of data, including only signed projects from a sample of 60 developing countries is used for the analysis. It contains 460 project observations in 45 countries. We also build control group of 15 other developing countries with no active PSP projects in the water and sanitation sector. The countries included in the control group have all indicated a willingness to consider PSP in the water and sanitation sector, either by introducing a national policy to that effect or engaging in negotiations with one or more private investors for a project in the sector. Countries in which PSP in the water sector is expressly forbidden by law or policy are not included.[18]

The Dependent Variable

We use the count of PSP contracts signed as our dependent variable (DV) for the regression analysis. Other papers on PSP employ investment volumes as the dependent variable. While this offers obvious advantages, non-the-least linearity, we refrain from using investment volumes as our dependent variable.

We have concerns about the quality of the data available for private investment volumes in the water sector. A first problem arises in the way that the figures are collected. For divestitures, the recorded investment figures refer to the purchase price of equity. For concessions, the figures refer to the investment commitments made by the concessionaire under the contract. In the World Bank PPI Database, equity sales are recorded in the year of the transaction, while investment commitments for concession are recorded in the year of financial closure, or in the year of the transaction, where the investments are phased and only if this information is known. However, after the initial transaction, information on investment levels for concessions is often not made available publicly. Where information is available, it seems that the actual level of investment by the private firm may diverge widely from the commitments made in the contract. Additionally, a large proportion of PSP contracts in the water sector are renegotiated

[16] The sources of data are: World Bank, Thomson Financial, Global Water Intelligence, Water Market China (Blanc-Brude and Jensen 2004), Water Market Asia (Blanc-Brude and Jensen, 2006) and numerous media and company releases. These data are cross-checked in interviews with operators, financiers, legal advisers and international institutions.

[17] 'BOT-type' includes BROT, BOOT, ROT and DBO contracts. Lease-type contracts include TOT and DBL. O&M type includes all contracts that do not require the private party to make any capital investment. See section 2 for a discussion of PSP contract acronyms and their limitations as proper economic concepts.

[18] Uruguay introduced a constitutional amendment in 2004 to prevent private provision of water services. However, as this decision was made only at the end of the period that we are considering (1990 and 2004), we include Uruguay in the dataset.

and it is common for the revised contract to include the rescheduling of investment commitments (Guasch 2004).[19]

Investment figures are also only available for a smaller sample of projects. These tend to be the largest transactions, those involving international investors, and divestitures rather than concessions, generating a biased sample of the population of water PSP contracts.

Henisz and Zelner use service outcomes (the number of lines per capita) as the dependent variable in their analysis of the telecoms sector (Henisz and Zelner 2001). This approach allows the authors to deal with the problem of unproductive investments, but would not allow us to isolate the effect of institutional variables on private investment, rather than public investment. In the water sector, private sector involvement is often relatively recent, and covers only a small section of the population. We would therefore expect the relationship between the level of private sector involvement and infrastructure penetration to be weak and we do not pursue the use of outcomes as a dependent variable. Furthermore, insufficient data are available on the production volumes or population served by projects and those data available come from multiple sources and may be inconsistent and unreliable.

While reliable data on investment volumes (both public and private) or the number of users served by public or private would undeniably yield interesting results and allow for OLS-type regression analysis, this information does not exist on a reliable basis. Anecdotal evidence collected in Asia by the authors indicates that concessionaires sometimes ignore how many people they are serving, while regulators ignore how much concessionaires have invested.

Thus, while the count of projects awarded does not reflect the importance of the private sector in providing water and sanitation services in a particular country, in the context of the present research, it will help explaining the decision of the government and the firm to engage in a partnership, what we have labelled "the handshake".

A final remark is needed on the difference between signed and active projects. Looking at the data, a small number of projects have been *officially* terminated, yielding different figures for the number of contracts signed and the number of projects that are currently active. This does not, however, account for the many shades of grey between truly active projects and those that, once signed, are still being discussed, renegotiated, arbitrated, etc (e.g. Suez' Manila concession can only be counted as terminated since 2005, but has in effect been 'in distress' since 1998). The literature and qualitative research undertaken by the authors on concession contracts (Jensen, *forthcoming PhD thesis*) reveal that the decision to terminate a contract is very long and complex and we therefore choose to model this separately from the decision to engage in PSP, in forthcoming research.

The Independent Variables

We build a cross section of independent variables (IV) for our sample of 60 countries. Since the DV is the cumulative number of PSP projects awarded over a 15-year period, we use mean values to build the cross-section of IVs. We consider IVs from the following categories:

- **Market Size**: proxied by mean population (1990-2004)
- **Market Risk**: proxied by the ICRG Economic Risk Index (2004)
- **Ability-to-Pay**: proxied by mean GDP per capita (1990-2004)
- **Sector Performance**: proxied by urban "Coverage Gap" (mean urban population multiplied by the inverse of the 2002 WHO water coverage estimate for the urban sector)
- **Public Finance**: proxied by mean Debt/ GNI ratio (1990-2004)
- **Institutions**: proxied by the World Bank governance indicators for government efficiency, rule of law, political stability, control of corruption (all standardised indices) as well as contract enforceability (in number of days to enforce) and the ICRG investment profile index. All values for 2004.

[19] Field interviews conducted in Manila and Jakarta further substantiate this point.

Annex C describes the variables and their sources in greater detail. While classic quantitative variables such as population or GDP per capita are available for 1990-2004, institutional and risk indices are not. Indeed, most of theses indices were created during the latter part of the period under study.

However, the nature of institutions and the way such indices are built are such that the most recent values should allow us to capture the effects that we are interested in. The reason for this is twofold: first, institutions change very slowly and we are confident that the *relative* degree of, say, the rule of law, has been the same for the past 15 years between Angola and El Salvador or Ethiopia and Turkey. Second, the World Bank governance indicators and the ICRG risk indices were built for comparative purposes, to capture exactly that kind of variance between countries worldwide, and each individual value only changes very little each time the indices are updated. We are confident that using the 2004 value for these variables will allow us to capture the cross-country effects we are interested in. However, a further note of caution is necessary regarding institutional variables.

It has proved very difficult to generate indicators for institutional quality that capture the relevant aspects of institutions. These indicators fall into two categories: objective indicators and perceptions indicators. Both are subject to measurement error. Objective indicators often capture only one aspect of the underlying institutional phenomenon that is of interest to the researcher. For example, data on the number of days that it takes to enforce a contract can be used as an indicator of the quality of legal and judicial institutions. However, this is only one of several relevant features of those institutions. Others could include corruption or arbitrariness in the system, which may be more important from the investor's point of view. Furthermore, objective indicators often do not capture the implementation of regulation or policy. On the other hand, perceptions indicators are subject to measurement error of a different kind: non-specificity and halo effects, where respondents' answers are affected by the general level of prosperity in a country (Kaufmann, Kraay et al. 2005). For the purposes of this research, we employ indices which combine objective with perceptions indicators. We are nevertheless well aware of the difficulty of finding indicators that reflect adequately underlying institutional attributes.

The Model

Market size, market risk, ability-to-pay and public finance are assumed to have nonlinear relationship with the predicted mean of project count (i.e. the predicted occurrence of PSP contract signature[20]). We assume that these relationships are best described by the natural log function: beyond a certain threshold, the effect of the variable tends to wear off. For instance, we hypothesize that the ability to pay for service will partly determine the extent of private sector involvement, but beyond a certain level of wealth, this is unlikely to make a difference.

Thus our model is:

PSP = *f*(Market Size, Market Risk, Ability-to-Pay, Sector Performance, Public Finance, Institutions)

Next, we test for correlation between independent variables. The correlation matrix in Annex A shows that institutional variables are highly correlated. To avoid multicolinearity and loss of explanatory power, we chose to test each institutional variable separately.

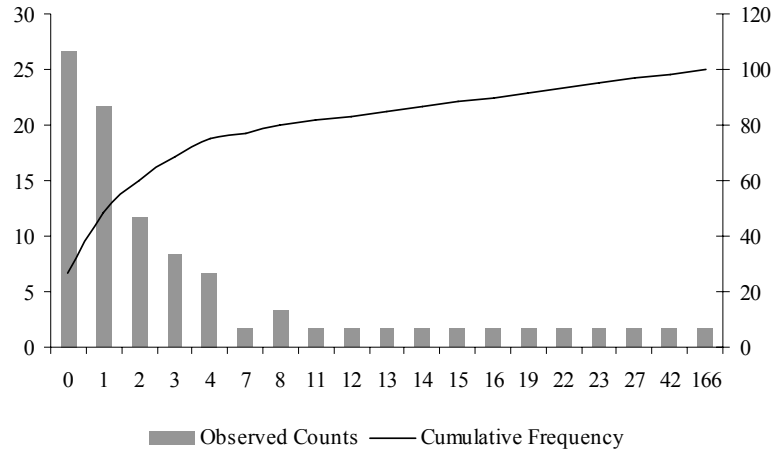
5 - Count Outcome Models and Regression

Count variables indicate the number of times an event has occurred, and the model estimates the probability of the event occurring a certain number of times. The use of regression models for counts is relatively recent but has wide ranging applications in social sciences and, in this case, in investment decision analysis. Figure 5 describes the counts of signed water PSP contracts in our sample.

[20] See section 5 and annex D for a detailed explanation of count models and of the regression model used here.

While the linear regression model has often been applied to count outcomes, this can result in inefficient, inconsistent, and biased estimates. Moreover, count distributions are rarely statistically normal. Even though there are situations in which the linear models provide reasonable results, findings can be more robust with models specifically designed for count outcomes.

Figure 5: Frequency of WATSAN PSP project counts



The univariate Poisson distribution is the foundation of regression models for counts. The Poisson regression model (PRM) extends the Poisson distribution by allowing each observation to have a different value of μ, the unique value of the mean and variance of the Poisson distribution. In practice the PRM rarely fits due to *over-dispersion*. That is, the model underestimates the amount of dispersion in the outcome. The negative binomial regression model (NBRM) addresses the failure of the PRM by adding a parameter α that reflects *unobserved* heterogeneity among observations.

The PRM and the NBRM have the same mean structure. That is, if the assumptions of the NBRM are correct, the expected rate for a given level of the independent variables will be the same in both models. However, the standard errors in the PRM will be biased downward, resulting in spuriously large *z*-values and spuriously small *p*-values (Cameron and Trivedi 1998). The NBRM thus appears preferable to the PRM. See Annex D for a full analysis of the regression of our dataset comparing the results of the PRM and of the NBRM, and Long and Freese (2001) for more details about count outcome regression models.

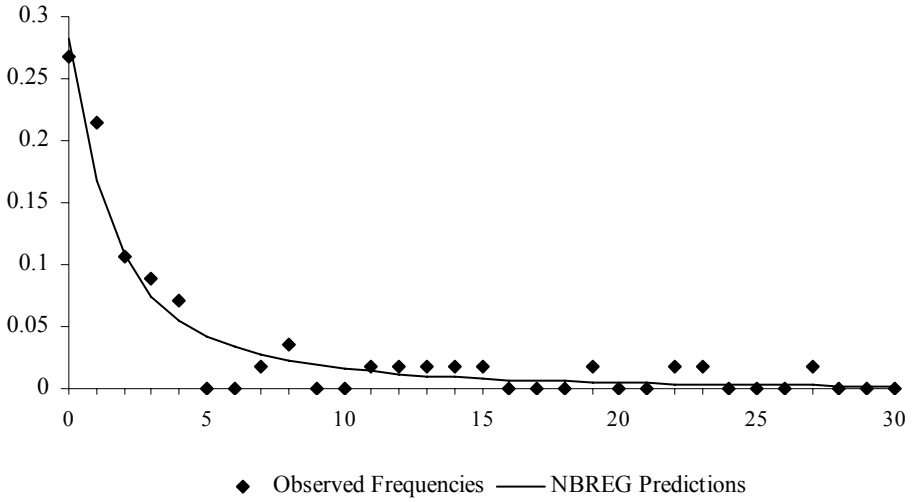
We estimate our basic model (without the institutional variables) with the NBRM using STATA 8.2.

Negative binomial regression			Number of obs. = 56		LR chi2(5) = 62.83	
DV: Number of Signed PSP Contracts			Pseudo R2 = 0.2036		Prob > chi2 = 0.0000	
	Coefficient	Std Error	Z	P>|z|	[95% Conf. Interval]	
Population	.5880215	.1261757	4.66	0.000	.3407216	.8353213
GDP per Capita	.9950203	.2148994	4.63	0.000	.5738251	1.416215
ICRG Risk	3.25384	1.808789	1.80	0.072	-.2913212	6.799002
Coverage Gap	.0000794	.0000312	2.54	0.011	.0000181	.0001406
Debt/ GNI	.5546001	.3261312	1.70	0.089	-.0846054	1.193806
Constant	-28.54979	6.39603	4.46	0.000	-41.08578	-16.01381
Likelihood-ratio test of alpha=0: chibar2(01) = 36.43 Prob>=chibar2 = 0.000						

Figure 6 plots the observed and predicted frequencies using the NBRM-fitted model. We can see that the model fits the data correctly even though it tends to slightly over estimate the number of zeros[21].

[21] The PRM fitted with the same data tends to underestimate zero counts.

Figure 6: Observed and Predicted Frequencies of PSP Counts



6 - Results and Interpretation

The detailed results for the regression of the different models can be found in Annex A. The following table summarises the results in percent change in expected PSP project count for one standard deviation increase in X, holding other variables constant.

Percent change in expected project count for one standard deviation increase in X								
Variable	**Transf.**	**Basic Model**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Population	Natural Log	178.8***	148.6***	142.9***	144.9***	140.1***	233.6***	179.9***
GDP per capita	Natural Log	138.4***	158.5***	152.1***	169.5***	156.2***	171.1***	164.9***
Debt/GNI	Natural Log	40*	47.3**	51**	41.3*	47.2**	57.8**	57.3***
ICRG Economic Risk Index	Natural Log	39*	31.1	23	34.8*	31.2	24.2	24.7
Urban Coverage Gap	Raw	44***	45.3***	44***	35***	46.6***	42.8***	55***
Rule of Law	Raw		35.4**					
Government Effectiveness	Raw			49.6***				
Political Stability	Raw				31*			
Control of Corruption	Raw					39.3**		
Contract Enforcement	Raw						-28.7*	
ICRG Investment Profile	Natural Log							42.7***

**** Significant at 1%; ** significant at 5%; * significant at 10%*

The results should be read (looking at the first cell for the basic model): an increase of one SD of the log of the population variable increases the expected mean of project signature count by 178.8% with 99% confidence. Likewise, looking at model 1, an increase of one SD of the rule of law index (which corresponds, for example, to the difference between the scores of Angola and Argentina) increases the expected mean of projects signature count by 35.4% with 95% confidence.

Overall, the results of the regression provide strong support for our hypotheses. The basic components of demand for water services, the size of the population and its ability to pay are significant at the 1% level and take the expected positive sign in all the models. We also observe that ability-to-pay has an impact on PSP that is comparable to the effect of market size.

Turning next to the factors which drive government demand for the involvement of the private sector, we find that level of indebtedness of a country is significant in all the models, generally at the 5% level.

We understand this relationship to operate through the following mechanism: governments of more highly indebted countries find it more difficult to access credit, putting pressure on the government to engage in fiscal stabilization. Governments then reduce their investment expenditure on infrastructure as part of their

stabilization efforts as this is less politically costly than reducing current expenditures. In order to compensate for this reduction in infrastructure expenditure, the government turns to the private sector for project financing.

A second possible mechanism would be that countries with high levels of indebtedness are more likely to come under pressure from international financial institutions. However, the effect of the volume of multilateral lending (not shown here) did not generate a significant result and had to be dropped. This may be because countries which receive large volumes of loans from multilaterals are less likely to have PSP projects for other reasons.

A third mechanism linking debt to PSP is the effect on macroeconomic risk faced by investors. More indebtedness raises macroeconomic and sovereign risks, discouraging investors from engaging in projects. However, the positive sign on the coefficient indicates that the effect of indebtedness on government demand for PSP is more powerful than any risk effect on investors.

A more general measure of macroeconomic risk, the ICRG economic risk index, does appear as significant at the 10% level in some of the models, but this finding is not robust across all the specifications. As we would expect macroeconomic risk to influence the investor's decision, we interpret this finding as an indication that investors are willing to take on more risk if the expected returns from the investment are high enough. This is supported by the high proportion of foreign investors in the sector, most of whom make investment decisions on a portfolio basis and are thus open to facing high risks in emerging markets. Unfortunately, at this stage, we are not able to include a measure of returns in our models. An alternative explanation for the absence of significance of the risk variable is that project due diligence can be poor and some macro risks badly evaluated *ex ante*. This last point is supported by many of our field interviews with practitioners and legal counsels.

The second driver of government demand for PSP that we test is the urban coverage gap. This is an indicator of poor water sector performance and may proxy for the strength of interest group demand for the extension of service networks in cities. Ideally, we would include a measure of service quality as well, to reflect the demands of existing utility customers for better services, but comparable data is generally not available at the national level. The urban coverage gap appears as highly significant in all our models.

Turning to the institutional characteristics of countries, we find that the indicators chosen perform well. In particular, we can see that the protection of property rights, reflected in the ICRG investment profile indicator, is significant at one percent, as is the measure of bureaucratic quality, 'government effectiveness'.

As the four World Bank governance indicators have the same format (see Annex C), their effects are directly comparable. We find that government effectiveness has the biggest positive effect, followed by the protection of property rights, the control of corruption and the rule of law. The rule of law indicator, which captures the quality of the judiciary, as emphasized by Levy and Spiller (1994), is significant at the 5% level. This somewhat lower level of significance may reflect the fact that this variable captures aspects of the rule of law that are less directly relevant to investors in the infrastructure sector, like the costs of common and organized crime and the quality of the police. A similar argument for the dilution of the effect of the variable may be made for political stability, which encompasses armed conflict and the risk of terrorism as well as the more directly relevant aspects of stability such as frequent or violent regime change or the extent of civil unrest.

The contract enforcement variable performs less well, consistent with Acemoglu and Johnson's findings (2003). This variable may reflect better the problems associated with enforcing contracts between private parties, which are distinct from the problems associated with public-private agreements. An alternative explanation is that infrastructure investment in emerging markets has little to do with enforceability, especially for foreign investors, who rely on international arbitration for dispute resolution. Few PSP contracts attribute legal competence to local courts and even the likelihood of arbitration awards being

enforced is usually limited. In the words of a senior project finance lawyer based in Asia: "a good contract gives you a seat at the negotiation table, not more."[22]

The very positive effect of the control of corruption can be surprising at first in a sector (construction) that is very prone to corruption and where competitive bidding has not always been the norm. This finding is however consistent with most studies of the link between investment, particularly FDI, and corruption (Moosa 2002).

However, we must be cautious in interpreting the significance of the different institutional indicators. Some of the indicators exhibit multi-collinearity, which suggests that the indicators are capturing some of the same underlying institutional attributes for which we do not have more direct indicators. In the absence of better indicators that would allow us to 'unpack' institutions, the key finding is that the institutional indicators as a group do appear as significant. In order to pursue the analysis of the impact of institutions on infrastructure investment flows, qualitative analysis would be a promising approach.

7 – Conclusion

Quantitative research on private participation involvement in the water sector has been held back until now by limitations in the data. The poor quality of the data is in turn due to the relatively lower levels of investment in water and sanitation and the smaller average project size, compared to other infrastructure sectors. International data on infrastructure penetration and the operating and financial performance of water utilities that can be used for cross-country analysis is very limited because of the highly fragmented structure of the sector. Many national governments do not collect information from municipal and regional providers.

The development of the WATSAN PSP database is a first step towards closing this gap in the literature. This new database includes well over twice the number of projects covered by the best existing source, the World Bank PPI Database. While this constitutes a significant improvement, we are currently deepening and strengthening the WATSAN PSP database further to allow for more extensive analysis.

With the information available, we are able to use a negative binomial count regression model to carry out a first analysis of the factors affecting PSP contract signature (the "handshake") in the water and sanitation sector. We find that demand for higher coverage levels and constraints on government finances are significant variables. Institutions that support the government's commitment to uphold its agreements with private partners and to maintain stable regulatory arrangements are also important. Among these, investor protection against expropriation and the quality of the bureaucracy emerge as the most significant. However, the indirect measures of institutional characteristics provided by the existing indicators do not allow us to identify the underlying institutional attributes that are significant to PSP rates. This points to the need for qualitative analysis to help identify these underlying attributes and the mechanisms through which they affect investment.

This initial analysis of the new dataset has delivered promising results and suggests a number of areas worthy of further investigation. Firstly, the institutions captured in indices like the 'rule of law' and 'government effectiveness' developed by the World Bank need to be unpacked. More precise measures of the institutions relevant to private investment in infrastructure need to identified and tested. Secondly, more information on legal and regulatory structures for water and sanitation across countries is needed to study the relationship between these sector-specific institutions and the level of private investment in the sector. The operational and financial performance of the sector seems a likely driver for PSP but cannot be tested because of the absence of country-level data. Thirdly, the role of international financial institutions in shaping government preferences with regard to PSP could be investigated further. Recent research pointing to a political backlash against policies linked with IFI involvement suggests a complex and interesting relationship (Henisz and Zelner 2004). Finally, it would be interesting to extend the analysis to

[22] Interview: Milbank LLP, Singapore, February 2004

include the exit decision of investors and the circumstances in which investors choose to terminate a water PSP contract.

These preliminary findings point to the existence of economic and institutional determinants to private infrastructure and water investment decisions that are sector specific and not necessarily in line with traditional findings for investment decisions (especially FDI). The specific characteristics of the sector, its political economy, the type of investors involved and the financing of PSP are all worthy of further exploration to better characterise private sector participation in the water sector, and across infrastructure sectors.

*

ANNEX A: Regressions & Correlation Matrix

Negative Binomial Count Model for WATSAN PSP in Developing Countries

Variable	Transf.	Basic Model Coef (z values)	Model 1 Coef (z values)	Model 2 Coef (z values)	Model 3 Coef (z values)	Model 4 Coef (z values)	Model 5 Coef (z values)	Model 6 Coef (z values)
Population	Natural Log	.5880215 (4.66)***	.6427902 (5.20)***	.6256657 (5.34)***	.6708151 (5.19)***	.6366447 (5.27)***	.7036564 (5.00)***	.6539809 (5.35)***
GDP per capita	Natural Log	.9950203 (4.63)***	.8835992 (4.16)***	.8610534 (4.23)***	.8692786 (4.02)***	.8501009 (3.97)***	1.189205 (5.29)***	.9911512 (4.86)***
Debt/GNI	Natural Log	.5546001 (1.70)*	.638496 (2.01)**	.6800456 (2.17)**	.5698847 (1.84)*	.6376125 (2.03)**	.7445108 (2.16)**	.7721402 (2.37)***
ICRG Economic Risk Index	Natural Log	3.25384 (1.80)*	2.655701 (1.52)	2.068255 (1.19)	2.932969 (1.70)*	2.669317 (1.55)	2.124386 (1.14)	2.350292 (1.32)
Urban Coverage Gap	Raw	.0000794 (2.54)***	.0000809 (2.71)***	.000079 (2.74)***	.000065 (2.10)**	.0000828 (2.81)***	.0000752 (2.44)***	.000094 (3.14)***
Years since 1st Infra PSP	Raw	(exposure variable)	(exposure variable)	(exposure variable)	(exposure variable)	(exposure variable)	(exposure variable)	(exposure variable)
Rule of Law	Raw		.490248 (1.92)**					
Government Effectiveness	Raw			.6573652 (2.45)***				
Political Stability	Raw				.3540364 (1.80)*			
Control of Corruption	Raw					.5965077 (1.99)**		
Contract Enforcement	Raw						-.0014658 (-1.70)*	
ICRG Investment Profile	Natural Log							1.397096 (2.35)***
Intercept		-28.54979 (-4.46)***	-26.38656 (-4.26)***	-24.18575 (-3.91)***	-27.22815 (-4.44)***	-26.09864 (-4.25)***	-27.19408 (-4.35)***	-29.8503 (-4.83)***
Observations		56	56	56	56	56	56	55
Likelihood Ratio Chi-Square		62.83***	66.38***	68.44***	65.90***	66.71***	63.07***	67.01***
Pseudo-R2		0.2036	0.2151	0.2218	0.2135	0.2162	0.2158	0.2182
Chi/Square(1) test of alpha = 0		36.43***	26.30***	23.52***	26.05***	25.49***	28.01***	31.51***

**** Significant at 1%; ** significant at 5%; * significant at 10%*

Correlation Matrix

	Population (ln)	GDP per Capita (ln)	ICRG Eco Risk (ln)	Urban Coverage Gap	Debt/GNI (ln)	Rule of Law	Government Effectiveness	Political Stability	Control of Corruption	Contract Enforcement	ICRG Invest Profile (ln)
Population (ln)	1										
GDP per Capita (ln)	-0.3424	1									
ICRG Economic Risk (ln)	-0.0325	0.5563	1								
Urban Coverage Gap	0.6856	-0.2406	0.0882	1							
Debt/GNI (ln)	-0.1104	-0.499	-0.3544	-0.2503	1						
Rule of Law	-0.3152	0.6434	0.3823	-0.2283	-0.3802	1					
Government Effectiveness	-0.1747	0.6475	0.4753	-0.0857	-0.4441	0.9443	1				
Political Stability	-0.408	0.5769	0.3719	-0.1734	-0.3075	0.8529	0.8126	1			
Control of Corruption	-0.3497	0.6981	0.4091	-0.2416	-0.3949	0.9455	0.9259	0.7768	1		
Contract Enforcement	0.0977	0.0214	-0.146	0.004	0.0722	-0.2505	-0.2749	-0.2084	-0.245	1	
ICRG Investment Profile (ln)	-0.3468	0.5224	0.3409	-0.2883	-0.3684	0.7205	0.6879	0.7181	0.7062	-0.0706	1

ANNEX B: Descriptive Statistics

Descriptive statistics

	Whole Sample	LIC	LMC	UMC	Latin America	Africa	Asia	Eastern Europe
Country	60	20	23	17	16	19	13	12
Number of contracts awarded	460	50	241	168	132	28	253	47
Mean*	7.67	2.50	10.48	9.88	8.25	1.47	19.46	3.92
SD	22.29							
Skewness	6.190355							
Kurtosis	43.97063							
Active projects	433	43	225	165	130	26	230	47
Early termination	27	8	16	3	2	2	23	0
active/total	94%	86%	93%	98%	98%	93%	91%	100%
term/total	6%	16%	7%	2%	2%	7%	9%	0%

**Mean (outliers correction i.e. China): 5.6, SD (outliers correction): 9.34*

Projects with international participation 460 Observations

	Whole sample	LIC	LMC	UMC	LatAm	Africa	Asia	Eastern Europe
Foreign Investor	272	29	138	105	73	27	127	45
Domestic Investor	188	22	103	63	59	1	126	2
International/Total	59%	58%	57%	63%	55%	96%	50%	96%

Project type 430 Observations

	Whole sample	LIC	LMC	UMC	LatAm	Africa	Asia	Eastern Europe
BOT-type	273	24	153	96	92	13	154	14
Concession	47	5	30	12	10	3	32	2
Divestiture	30	0	4	26	20	0	5	5
Lease type	49	12	15	22	6	7	15	21
O&M	31	10	9	12	4	5	17	5

PSP Counts Frequency Distribution																			
PSP Signed	0	1	2	3	4	7	8	11	12	13	14	15	16	19	22	23	27	42	166
Freq.	16	13	7	5	4	1	2	1	1	1	1	1	1	1	1	1	1	1	1
Percent	26.7	21.7	11.7	8.33	6.7	1.67	3.3	1.67	1.67	1.7	1.67	1.67	1.7	1.67	1.67	1.7	1.67	1.67	1.7
Cum.	26.7	48.3	60	68.3	75	76.7	80	81.7	83.3	85	86.7	88.3	90	91.7	93.3	95	96.7	98.3	100

ANNEX C: Independent Variables

Variable	Source	Years	Description
Number of contracts awarded (Sum)	WATSAN PSP Database	1990-2004	Database compiled by the authors. Sources: World Bank PPI Database, Thomson Financial, Global Water Intelligence and other media sources, Water Market China. Cross-checked through interview with practitioners
Population (Average)	Economist Intelligence Unit	1990-2004	
GDP per capita (Average)	Economist Intelligence Unit	1990-2004	
ICRG Economic Risk	PRS Group International Country Risk Guide	2004	Composite index of GDP, GDP growth, inflation, budget balance and current account balance. The economic risk index scores range from 0-50 points. See: **http://www.icrgonline.com/page.aspx?page=icrgmethods**
Urban Coverage Gap	Authors	2002	The variable is constructed using data for urban population and access to improved water supply. Urban coverage gap = Urban population x (1-urban access to improved water supply) Average urban population 1990-2004 (EIU) Access to improved water supply (urban areas) 2002 (WHO JMP). See **http://www.wssinfo.org/**
Years since first infrastructure PPP (No.)	World Bank PPI Database	1990-2004	Count of number of years between the first recorded private investment in infrastructure recorded in the database and 2004. A first investment in 2004 receives a score of 1. A first investment in 1990 receives a score of 15.
Rule of Law	World Bank Governance Indicators	2004	Measures the extent to which agents "have confidence in and abide by the rules of society". Includes: incidence of crime, the effectiveness and predictability of the judiciary, and the enforceability of contracts. Scores are normalized around 0. See: **http://www.worldbank.org/wbi/governance/govdata/**
Government Effectiveness	World Bank Governance Indicators	2004	Measures the quality of public service provision, the quality of the bureaucracy, the competence of civil servants, the independence of the civil service from political pressures, and the credibility of the government's commitment to policies. Scores are normalized around 0. See: **http://www.worldbank.org/wbi/governance/govdata/**
Political Stability	World Bank Governance Indicators	2004	Measure perceptions of the likelihood that the government in power will be destabilized or overthrown by possibly unconstitutional and/or violent means, including domestic violence and terrorism. Scores are normalized around 0. See: **http://www.worldbank.org/wbi/governance/govdata/**
Control of Corruption	World Bank Governance Indicators	2004	Measures perceptions of corruption, defined as "the exercise of public power for private gain." Includes small-scale and 'grand' corruption. Scores are normalized around 0. See: **http://www.worldbank.org/wbi/governance/govdata/**
Contract enforcement	World Bank Doing Business Database	2004	Average number of days to enforce a contract
ICRG Investment Profile	PRS Group International Country Risk Guide	2004	Composite index reflecting contract viability, profits repatriation and payments delays. Scores range from 0-15, with a score of 15 for the most attractive investment profile See: **http://www.icrgonline.com/page.aspx?page=icrgmethods**

Annex D: Count Outcome Models

This Annex describes how count outcome models can serve the purpose of testing the determinants of the PSP projects identified in our database. It borrows heavily from Long and Freese (2001).

The Poisson Distribution
The univariate Poisson distribution is the foundation of regression models for counts. Let y be a random variable indicating the number of times an event has occurred. If y has a Poisson distribution, then:

$$\Pr(y \mid \mu) = (e^{-\mu} * \mu^{y}) / y! \qquad \text{for } y = 0, 1, 2, \ldots \qquad (1)$$

where $\mu > 0$ is the sole parameter defining the distribution

μ is the mean of the Poisson distribution. μ is also the variance. Thus, $\text{Var}(y) = \mu$, which is known as *equidispersion*. With most datasets, many count variables have a variance greater than their mean, which is called *overdispersion*. As μ increases, the probability of a zero count decreases. Thus, for many count variables, there will be observed zeros than predicted by the Poisson distribution.

The Poisson Regression Model
The Poisson regression model (PRM) extends the Poisson distribution by allowing each observation to have a different value of μ. More formally, the PRM assumes that the observed count for observation i is drawn from a Poisson distribution with mean μ_i, where μ_i is estimated from observed characteristics. This is sometimes referred to as incorporating *observed heterogeneity*, and leads to the structural equation:

$$\mu_i = E(y_i \mid x_i) = \exp(x_i\beta) \qquad (2)$$

Using the exponential of $x\beta$ forces μ to be positive; this is necessary since counts can only be zero or positive. For each value of μ, the distribution around the mean represents the probability of each count. Interpretation of the model involves assessing how changes in the independent variables affect the conditional mean and the probabilities of various counts.

Exposure time
In our sample, not all countries introduce PSP in the water sector at the same time. Statistically, different observations will have different *exposure* times i.e. each observation is 'at risk' of having a positive count for a different amount of time. In our example, each country will have been 'at risk' of having a positive count of private project for as long as a country's legal framework allows private participation in the water sector. Before that date the probability of counting zero projects is by definition equal to unity, and the probability to count more than zero projects is nil.

We create an exposure variable (FIRSTPSP) which measures the number of years since the first private infrastructure project (not just in the water sector) was signed in country i. For most countries this signals the beginning of reform of public utilities and the point after which a private water project becomes possible. The data for FIRSTPSP is drawn from the World Bank's PPI database.

Exposure times can be incorporated quite simply into count models. Let t_i be the amount of time that observation i is at risk. If the rate (i.e., the expected number of observations for a single unit of time) for that case is μ_i, then we would expect $t_i * \mu_i$ to be the expected count over a period of length t_i. Then, assuming only two independent variables for simplicity, our count equation becomes:

$$\mu_i * t_i = [\exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2)] \times t_i \qquad (3)$$

Since $t = \exp(\ln t)$ we have $\mu_i * t_i = \exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ln t_i)$

This shows that the effect of different exposure times can be included as the log of the exposure time with a regression coefficient constrained to equal unity.

The Negative Binomial Regression Model

We now address over-dispersion in our sample. The PRM accounts for observed heterogeneity (i.e., observed differences among sample members) by specifying the rate μ_i as a function of observed x_k's. In practice the PRM rarely fits due to *over-dispersion*[23]. That is, the model underestimates the amount of dispersion in the outcome. The negative binomial regression model (NBRM) addresses the failure of the PRM by adding a parameter α that reflects *unobserved* heterogeneity among observations. For example, with three independent variables, the PRM is:

$$\mu_i = \exp(\beta 0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \beta_3 x_{i3}) \qquad (4)$$

The NBRM adds an error ε that is assumed to be uncorrelated with the x's,

$$\begin{aligned}\mu_i &= \exp(\beta 0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \beta_3 x_{i3} + \varepsilon_i) \\ &= \exp(\beta 0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \beta_3 x_{i3}) \exp(\varepsilon_i) \\ &= \exp(\beta 0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \beta_3 x_{i3})\, \delta_i\end{aligned}$$

where the second step follows by basic algebra, and the last step simply defines $\delta \equiv \exp(\varepsilon)$. To identify the model, we assume that $E(\delta) = 1$ which corresponds to the assumption $E(\varepsilon) = 0$ in the PRM. With this assumption, it is easy to show that:

$$E(\mu) = \mu E(\delta) = \mu$$

Thus, *the* PRM *and the* NBRM *have the same mean structure*. That is, if the assumptions of the NBRM are correct, the expected rate for a given level of the independent variables will be the same in both models. However, the standard errors in the PRM will be biased downward, resulting in spuriously large z-values and spuriously small p-values (Cameron and Trivedi 1998).

The distribution of observations given both the values of the x's *and* δ is still Poisson in the NBRM. That is,

$$\Pr(y_i \mid \mathbf{x}_i, \delta_i) = (e^{-\mu i} * \mu^{yi}{}_i) / y_i! \qquad (5)$$

Since δ is unknown, we cannot compute $\Pr(y \mid \mathbf{x})$. This is resolved by assuming that δ is drawn from a gamma distribution (see Long (1997: 231-232) or Cameron and Trivedi (1998:70-79) for details). Then we can compute $\Pr(y \mid \mathbf{x})$ as a weighted combination of $\Pr(y \mid \mathbf{x}, \delta)$ for all values of δ, where the weights are determined by $\Pr(\delta)$. This leads to the negative binomial distribution:

$$\Pr(y \mid \mathbf{x}) = [\Gamma(y + \alpha^{-1}) / y! * \Gamma(\alpha^{-1})] * [\alpha^{-1} / (\alpha^{-1} + \mu)]^{\alpha^{-1}} * [\mu / (\alpha - 1 + \mu)]^{y}$$
where Γ is the gamma function. (6)

The larger value of α, the greater spread in the data; indeed, if $\alpha = 0$, the NBRM reduces to the PRM, which turns out to be the key to testing for over-dispersion.

[23] *Using STATA 8.2 SE, we fit the Poisson regression for our basic model. As with most Poisson regressions applied to real-world data, we find a poor fit. Various measures of pseudo and adjusted R-squared are suspiciously high and the Chi-Square test for the goodness of fit of the regression forces us to reject the null hypothesis that our distribution is a Poisson distribution. The bad fit of the PRM is not a surprise since the standard deviation of our distribution is about three times the mean. This is partly due to the very high number of PSP projects in China. Even after for correcting for outliers (China), the SD of the distribution (9.34) is still almost twice the mean (5.6) – See Annex B for detailed descriptive statistics.*

We estimate our basic model (without the institutional variables) with the NBRM using STATA 8.2.

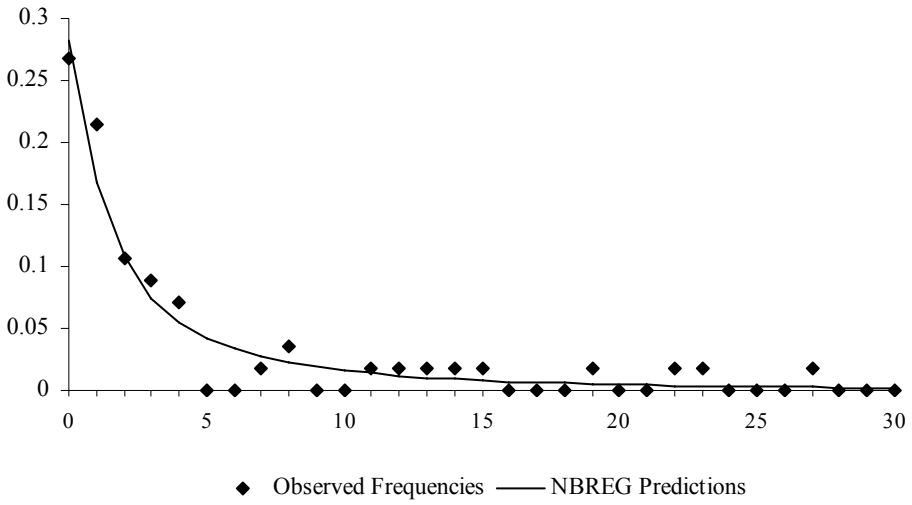
```
Negative binomial regression                      Number of obs   =         56
                                                  LR chi2(5)      =      62.83
                                                  Prob > chi2     =     0.0000
Log likelihood = -122.88584                       Pseudo R2       =     0.2036

------------------------------------------------------------------------------
   PSPSIGNED |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  LOGPOPMEAN |   .5880215   .1261757     4.66   0.000     .3407216    .8353213
LOGGDPCAPM~N |   .9950203   .2148994     4.63   0.000     .5738251    1.416215
  LOGICRGECO |    3.25384   1.808789     1.80   0.072    -.2913212    6.799002
 COVERAGEGAP |   .0000794   .0000312     2.54   0.011     .0000181    .0001406
 LOGBDEBTGNI |   .5546001   .3261312     1.70   0.089    -.0846054    1.193806
       _cons |  -28.54979    6.39603    -4.46   0.000    -41.08578   -16.01381
    FIRSTPPP | (exposure)
-------------+----------------------------------------------------------------
    /lnalpha |  -.8124094   .3793467                     -1.555915   -.0689036
-------------+----------------------------------------------------------------
       alpha |   .4437875   .1683493                      .2109962    .9334167
------------------------------------------------------------------------------
Likelihood-ratio test of alpha=0:  chibar2(01) =   36.43 Prob>=chibar2 = 0.000

Measures of Fit for nbreg of PSPSIGNED

Log-Lik Intercept Only:     -154.302     Log-Lik Full Model:         -122.886
D(49):                       245.772     LR(5):                        62.833
                                         Prob > LR:                     0.000
McFadden's R2:                 0.204     McFadden's Adj R2:             0.158
Maximum Likelihood R2:         0.674     Cragg & Uhler's R2:            0.677
AIC:                           4.639     AIC*n:                       259.772
BIC:                          48.529     BIC':                        -42.706
```

Figure 6: Observed and Predicted Frequencies of PSP Counts



The LR test for H0: alpha = 0 is highly significant and we can reject the null hypothesis and conclude that there is significant evidence of over-dispersion. From this and the Bayesian Information Criterion (BIC) we can see that the NBRM is to be preferred to the PRM.

Figure 6 plots the observed and predicted frequencies using the NBRM-fitted model. We can see that the model fits the data correctly even though it tends to slightly over estimate the number of zeros[24]. Having determined that the NBRM fits our data best, we can now test the different versions of the model.

[24] The PRM fitted with the same data tends to underestimate zero counts.

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