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"The determinants of contractual choice for private involvement in infrastructure projects in the United States"

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Abstract

Reliance on private partners to help provide infrastructure investment and service delivery is increasing in the United States. Numerous studies have examined the determinants of the degree of private participation in infrastructure projects as governed by contract type. We depart from this simple public/private dichotomy by examining a rich set of contractual arrangements. We utilize both municipal and state-level data on 472 projects of various types completed between 1985 and 2008. Our estimates indicate that infrastructure characteristics, particularly those that reflect "stand alone" versus network characteristics, are key factors influencing the extent of private participation. Fiscal variables, such as a jurisdiction's relative debt level, and basic controls, such as population and locality of government, increase the degree of private participation, while a greater tax burden reduces private participation.

JEL classification: H4; H54; H7; L88; L9
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1. Introduction

Critical parts of America's infrastructure are deteriorating and past their original design lives.[1] State and local governments responsible for that infrastructure often face severe fiscal problems, and do not possess the resources necessary to properly expand and maintain it. Federal funds for infrastructure maintenance are also dwindling. America's infrastructure challenges span a variety of facilities and sectors, including roads, bridges, tunnels, transit systems, dams, schools, and wastewater treatment plants, among others.

State and local governments are turning to the private sector for assistance with the design, financing, construction, expansion, maintenance and operation of critical infrastructure facilities. Thirty-one states have passed public-private partnership enabling laws, which are designed to facilitate private participation in infrastructure provision and operation.

This type of cooperation typically occurs through a contractual agreement between a group of private partners and a public project sponsor. Agreements can take on many forms. Private participation can occur through simple management contracts, where a private party is retained to operate existing facilities, such as schools, prisons, or toll roads. It can also occur through more complex end-to-end contracts where the private party designs, finances, constructs, and operates entirely new facilities. Private participation thus varies widely in intensity across different contract types.

Scholarly literature on contracts between the government and private partners is growing. Many works focus on the choice between public versus private delivery of public services (Bel and Fageda 2007, 2009 provide respectively reviews and meta-regression analyses), as well as works that analyze delivery reform choices beyond a simple public-private distinction (i.e. Warner and Hebdon, 2001, Warner and Hefetz 2002, Duffield, 2010). However, there has not yet been systematic empirical study of the factors driving the choice of the *degree* of private participation. We address that gap by categorizing private participation in infrastructure provision and operation into four main contractual types: design and build, management contracts, design-build-finance-operate (DBFO) agreements and concession agreements, and asset sales. We discuss each contract type below. We use both binary logistic and ordered logistic regression analysis to examine the effect of a broad set of fiscal, political, and infrastructure-type variables on the type of contract used.

[1] See e.g. American Society of Civil Engineers, "Report Card for America's Infrastructure," available at: http://www.infrastructurereportcard.org/ (accessed August 27, 2012).

Analyzing the degree of private involvement in the delivery of public infrastructure – beyond the traditional approach of studying determinants of the decision of whether to privatize or not – is important given increasing private involvement in infrastructure projects in the United States. Between 1990 and 2000 there were a total of 26 projects valued at $14.4 billion. Between 2001 and 2010, however, there were 46 projects valued at $34.8 billion. This represents a decade-over-decade increase of 77 percent in the total number of projects, and a 140 percent increase in value.

A salient characteristic of the projects is that private partners bear risks inherent in the construction and operation of the public infrastructure. Indeed, the degree of risk sharing and risk transfer to private agents is linked directly to the degree of private involvement, as indicated in works such as the Asian Development Bank (2008: 28). Public-Private Partnerships Handbook, which distinguishes between five basic types of projects (including service contracts, management contracts, lease contracts, concessions, and build-operate-transfer (BOT) contracts, on the basis of differences in (i) commercial risk (associated with demand risk); and (ii) overall level of risk assumed by the private sector.[2]

Our contribution is twofold. First, we provide evidence directly analyzing the drivers of contract choice in agreements that correspond to different levels of private involvement. We extend literature examining the determinants of contracting out decisions in order to focus on projects already "privatized" through contractual agreements and on the extent of risk assumption by the private partner. We thus move beyond treatment of the public/private choice as dichotomous. Second, after controlling for fiscal and political effects, we show that stand alone versus network characteristics of the infrastructure in question are leading factors explaining contract choice in the United States. We find that network characteristics, such as those related to transaction costs, sunk investments, and limited competition, are important drivers of the degree of private participation.

We next describe contract types in more detail, review some common contractual types, and provide examples of several contract types in the United States. Section III provides an overview of related literature. We describe our data set and both the dependent and independent variables we study in Section IV. Section V describes our empirical strategy, while Section VI reports and discusses empirical estimates. Section VII concludes.

[2] Among other factors. See as well for this purpose Anthony Boardman, Carsten Greve and Graeme A. Hodge, eds. (2010), *International Handbook On Public–Private Partnerships*, Edward Elgar.

2. Types of Contracts

We consider contracts ranging from relatively simple management contracts to complex design-build-finance-operate (DFBO) contracts, to outright asset sales. The traditional procurement approach has long included private sector participation, but in more limited ways. Under a traditional design-build (DB) approach, for example, a public sponsor engages (typically different) private firms to design and construct an infrastructure project. The public sponsor remains responsible for financing, operating, and maintaining the facility.

More complex contractual arrangements extend the traditional approach in that they enlist the private sector in undertaking a variety of added tasks, thus bundling different aspects of service provision. Such arrangements are sometimes called public-private-partnerships (Iossa and Martimort, 2011). One such arrangement is a design-build-operate-maintain, or DBOM contract, under which the additional duties of the private partner or partners include operating and maintaining the facility after construction. Similar to DB contracts, DBOM contracts seek to take advantage of private sector incentives and specialized expertise to design and build facilities in a way that will also minimize operation and maintenance costs.

Other contracts extend private participation through assistance in financing the project. In a typical DBFOM (design-build-finance-operate-maintain) contract, for example, the private sector agrees to design and build a new facility using some combination of debt (leveraged against future toll revenue in the toll road case) and equity, and then operates and maintains the facility for a specified time period in exchange for the right to collect revenues from the facility's use over the lease term. This project type, in which the private sector builds a *new* facility, is known as a greenfield project. This is in contrast to a brownfield project, under which the private partner typically pays an upfront concession fee in order to lease an existing facility.

Other contractual types include build-transfer-operate (BTO) agreements, under which the private partner actually owns the facility until its ownership rights are transferred to the public sector following the construction period. Similarly, under a BOT (build-operate-transfer) agreement, the private partner holds title to the facility until its ownership right is transferred at the end of the specified operation and maintenance period. In a build-own-operate (BOO) agreement, title remains with the private partner unless the public sector decides to purchase it. We next discuss four examples of these projects in the transportation sector in the United States. That sector has been the most widely studied so far. These examples help illustrate various contractual agreements and project types.

Hartsfield-Jackson Atlanta International Airport. The Hartsfield-Jackson International Airport in Atlanta, Georgia provides an example of a management contract. It is the busiest airport in the world, with almost 100 million passengers and nearly 1 million air traffic operations annually. International Concourse E was opened in 1994, and quickly became the largest international concourse in North America. While most of the airport is managed by the city of Atlanta, the 28-gate international Terminal E is managed by TBI, an international airport operator controlled by Abertis, a Spanish operator of tollroads, airports and other infrastructure.

In 1994, Terminal T was replaced with new terminal E, but kept under TBI management. TBI managed the old Atlanta Terminal T under a 30-year management contract concluded in 1980, which expired in 2010. Discussions focusing on a new management contract (with Abertis) are ongoing.

Abertis took over TBI in 2005, and Abertis Airports manages and controls many of the usual facilities, as well as information panels and flight runways. Hartsfield-Jackson is one of five airports in North America managed by Abertis Airports.

California 91 Express Lanes. The 91 Express Lanes in Orange County, California provide an example of a management contract in the toll road sector. The lanes are a ten-mile (16 km) high-occupancy toll road/full tollway combination in a highly congested section of the State. They are contained entirely within the median of the Riverside Freeway (State Route 91). The 91 Express Lanes project was a partnership between the California Department of Transportation (Caltrans) by California Private Transportation Company (CPTC). Prior to opening the facility to traffic in December of 1995, CPTC formally transferred ownership of the facility to the State. CPTC then leased the toll road back from Caltrans for a 35-year operating period.

A strict non-compete clause in the contract made this project controversial. The clause prevented any improvements, such as building mass transit or widening free lanes, along 30 miles of the Riverside Freeway. This includes restricting the state from widening the free lanes or building mass transit near the freeway. A protracted legal battle followed Caltrans' attempt to widen a nearby interchange, which resulted in a settlement.

The Express Lanes are now operated under a management contract signed in 2006 with Cofiroute USA. There are no tollbooths on the lanes, and all tolls are collected electronically using onboard transponders. To help manage congestion, the toll lanes use time-of-day pricing (as opposed to real-time, variable tolling).The project was developed through a partnership

between the California Department of Transportation (Caltrans) and the California Private Transportation Company (CPTC). The 91 Express Lanes management contract represents a relatively low level of private involvement.

Chicago Skyway. The Chicago Skyway concession is an example of a long-term toll road leasing, or brownfield, contract. The Skyway is a 7.8-mile toll road that is part of the I-90 interstate highway. It connects the Dan Ryan Expressway in Chicago to the Indiana Toll Road (I-90). The Skyway carried about 50,000 vehicles per day in 2005.[3]

In March 2004, the City of Chicago issued a request for qualifications from bidders interested in leasing the Skyway for a ninety-nine-year term. The city received ten responses, and five bidders were asked to submit detailed proposals. The high bid of $1.83 billion came from a partnership of Cintra Concesiones de Intrastructures de Transporte S.A. (Cintra) of Madrid, Spain, and the Macquarie Infrastructure Group of Sydney, Australia, which cooperated to create the Skyway Concession Company LLC (or SCC). The city awarded the contract to SCC in the first modern long-term lease of an existing U.S. toll road.[4]

Dulles Greenway. The Dulles Greenway is an example of a greenfield DBFO contract. The Dulles Greenway is a 14-mile, limited-access highway outside of Washington, D.C. It extends from the state-owned Dulles Toll Road, which connects the Washington, D.C., beltway going to Dulles Airport to Leesburg, Virginia. It opened to traffic in September 1995.

The Greenway was built under the Virginia Highway Act of 1988. The 1988 act was novel in that it did not grant the investors—the Toll Road Investors Partnership II (or TRIP II)—the power of eminent domain. Rather, the lands required to build the Greenway were assembled privately and purchased at market price.[5] The Act also required that the facility eventually be turned over to the State. However, traffic on the road was less than expected after it opened in 1995, and TRIP II defaulted on its debts. Its contract was thus renegotiated, and the concession life was increased. The road then became profitable.

[3] Nicholas Hann, *PPPs in North America—A Private Sector Partner's Perspective*, Maquarie North America Ltd., December 2006, http://csgb.ubc.ca/files/workshop06/Region4-Hann.pdf (accessed February 10, 2010).
[4] U.S. Department of Transportation, Federal Highway Administration, Office of Innovative Program Delivery, "Case Studies: Chicago Skyway," http://www.fhwa.dot.gov/ipd/case_studies/il_chicago_Skyway.htm (accessed February 10, 2010).
[5] U.S. Department of Transportation, Federal Highway Administration, Office of Innovative Program Delivery, "Case Studies: Chicago Skyway," http://www.fhwa.dot.gov/ipd/case_studies/il_chicago_Skyway.htm (accessed February 10, 2010).

The Greenway's regulation by the Virginia State Corporation Commission is also unusual. Its return is limited to 18 percent, similar to utility-style regulation. Unlike typical utility regulation, however, the Greenway receives no legally enforced monopoly through an exclusive territory. It continues to pay real estate taxes on property purchased to build the road, thus generating tax revenue that would not be forthcoming under traditional project provision in the United States.[6]

Tampa Bay Water at Brandon, Florida. In September 2011, Veolia Water North America and Tampa Bay Water in Florida began operation of the Tampa water treatment plant. This final phase of the project completed one of the largest design-build-operate (DBO) contracts in U.S. history. A first phase greenfield project with Veolia was completed in 2002 with a design capacity of 60 million gallons per day (mgd). In two more expansions leading up to September 2011, the project increased to 120 mgd. Tampa Bay Water chose Veolia's consortium after receiving bids from other groups to carry out this DBO project.

3. Theoretical and empirical background

Contracting out has often been subject to moral hazard problems because of full additional cost reimbursement under cost-plus contracts, as well as problems associated with quality measurement, among others (Donahue 1989; Levin and Tadelis 2010). Contracting out has however evolved to include high-powered incentives to help address those problems. That involves shifting risk to the private partner, which typically requires that the public sponsor pay a risk premium. Risk sharing between government and a private partner is a key issue in complex contracts for infrastructure provision (Engel, Fischer and Galetovic, forthcoming).

Theoretical and empirical analyses of private delivery of public services provides a useful background with which to study why a government will choose a contract to deliver a public service, as well as the degree of private involvement. There are several branches of the literature, which we now discuss.

[6] Note that unlike traditional public production in US, some European governments create and use publicly owned firms that operate and collect tolls. Despite being publicly owned, they must satisfy tax payments as private concessionaires do.

Public Choice theory predicts that, when politicians and bureaucrats monopolize the delivery of public services, overproduction and inefficiency results (Niskanen 1971). This can be solved by introducing competition for contracts, from which lower costs and more technical efficiency in service delivery can be obtained (Boyne 1998). Another relevant approach emerging from property rights theory builds on seminal works by Alchian (1967) and Alchian and Demsetz (1972). The theory of incomplete contracts developed in important works such as Grossman and Hart (1986) and Hart and Moore (1990) provides a useful analytical framework for studying situations in which contracting is a complex operation. Within that framework, Hart (1993) and Hart, Shleifer and Vishny al. (1997) show that private production provides incentives to reduce costs by means of reducing quality. That is, unless quality can be well defined and specified, the contracted firm may sacrifice quality in order to reduce totals costs (Bennet and Iossa, 2006). Contract completeness is a crucial issue regarding the choice of public services delivery, and this is linked directly to transaction costs (Williamson 1979, 1999). Monitoring and control thus play a central role in the privatization of public services (e.g. Sappington and Stiglitz 1987).

Based on these theoretical approaches, the available literature (see Bel and Fageda 2007, 2009 for summaries) has emphasized the relevance of different groups of factors in the decision to contract out: fiscal restraints, economic factors, and political factors.[7] We discuss each variable group below.

Fiscal constraints. Fiscal constraints have been one of the main drivers of asset sale privatization (Yarrow 1999, Bortolotti and Milella 2008). At the local level in the United States, the trend toward increasing tax burdens and the consequent weakening of fiscal constraints ended in the 1970s (Hoene 2004). Evidence of the influence of fiscal constraints in the contracting out of public services is less systematic than for asset sales. Although fiscal constraints do not appear to influence contracting out of local services in Europe, they have been a key factor in local privatization in the United States (Bel and Fageda 2009). “Tax revolts” in the 1970s and states’ legislation limiting increases in local taxation might have been important forces in driving this phenomenon.[8] Available evidence suggests that privatization in smaller municipalities is more strongly influenced by financial difficulties. Similarly, privatization can be used both to increase payments by users and to reduce funding from the general budget (Bel and Miralles 2010). Including fiscal variables designed to measure the effects of such restrictions is now common in

[7]Hammami, Ruhashyankiko and Yehoue (2006) analyze the determinants of the extent of private participation in infrastructure with a sample of PPPs in a variety of undeveloped countries. They find the control of corruption and common law origin are positively related to the extent of private participation. The sample and institutional heterogeneity used in that work make it substantially different from our own.

[8] Hoene (2004) contains an analysis on the effects of Proposition 13 on the fiscal regime of cities in California.

the literature. The underlying hypothesis suggests a positive relationship between fiscal constraints and private sector involvement and privatization.

Hypothesis one: The degree of private involvement is positively related to the fiscal stress affecting the contracting government.

Economic efficiency and network effects. Contracting for the delivery of public services using private participation breaks the public delivery monopoly and introduces competition. It might also be a way to encourage cost reduction (Savas 1987). Expectations of cost reduction from private delivery diminish when transactions costs are important (Sappington and Stiglitz 1987). According to Williamson (1999), the relative requirement of long-term investments specifically related to the transaction, or sunk costs, is a key consideration in contracting.[9] Because of these factors, the institutional organization required to establish and uphold contracts can be very complex, particularly when the contract involves network industries.[10] Empirical evidence suggests that transaction costs are negatively related to private involvement in the delivery of public services (Brown and Potoski 2003a, 2003b; Levin and Tadelis 2010). Evidence also indicates that cost reductions are less likely to be realized in services with important network characteristics, such as water distribution (Bel, Fageda and Warner 2010).

Hypothesis two: The degree of private involvement is negatively related to the network characteristics of the project, because of higher transaction costs and more complex institutional arrangements required.

Hypothesis three: The degree of private involvement is positively related to the density of public labor force, because more public labor force can be related to higher potential for cost savings from private involvement.

Political Processes and Ideological Attitudes. Variables measuring non-economic factors that might help explain the decision to privatize public services, such as political processes and ideological attitudes, have also been examined (Bel and Fageda, 2007, 2009). Two main motivations guide politicians' decisions in a democratic environment. Politicians seek to win elections and obtain governmental positions. However, they also have preferences for some

[9] This argument can be seen as closely related to that in Besley and Ghatak (2001) regarding the impurity of the goods and services as per their public goods characteristics.
[10] Network industries are often defined as industries with an extensive set of lines, pipes or routes, usually with strong interconnections between various components of the system.

policies over others according to their ideological predispositions.[11] Within the domain of political interests, the decision to privatize is dependent on the existence of pressure groups focused on obtaining the rents derived from a given form of service delivery (see e.g. McGuire, Oshfeldt and van Cott (1987) for school buses; Dubin and Navarro (1988) and Hirsch (1995) for solid waste collection; Chandler and Feuille (1994) for sanitation; and Miralles (2009) for water). Ideology may also influence privatization. Right-wing parties have been linked to more pro-business policies, whereas left-wing organizations are often associated with public values. If those characterizations are correct, right-wing control of government will be positively associated with privatization, while left-wing control will be associated with public production, as shown in Dubin and Navarro (1988), Dijkgraaf, Gradus and Melemberg (2003), Walls, Macauley and Anderson (2005), and Picazo-Tadeo et al (2012). We next describe empirical analyses examining the effects of these variable groups.

Hypothesis four: The degree of private involvement is positively related to the strength of Republican politicians.

4. Empirical Analysis

This section describes the data, variables and methods used to evaluate the impact of fiscal, political, infrastructure-type and other control variables on the extent of private participation in U.S. projects. We first describe the main data sources and report descriptive statistics. We then define and discuss the dependent variables in our dataset, moving next to independent variables. This section ends with a discussion of the models to be estimated and a summary of predicted effects.

4.1 Data

We use the *International Major Projects Survey 2008* from Public Works Financing (published in the October 2008 issue) as our main data source. This source contains information on infrastructure projects with private participation from around the world. For the United States, we located 508 projects between 1985 and 2008, although necessary information on contract

[11] This double dimension of the politician in a democratic system has been named the citizen-candidate approach. Osborne & Slivinski (1996) and Besley & Coate (1997) offer theoretical insights; Levitt, 1996 and Lee et al., 2004 offer empirical support.

types is only specified for 472.[12] The data provide detailed information on projects for different sectors, and on a wide range of contract types, which is important for construction of our dependent variables measuring the intensity of private involvement.

Table 1 displays basic information regarding sectors and services represented in the data, as well as sector characteristics. Recall that we are not interested here in the choice between public and private delivery, so our sample is restricted to projects were private involvement actually exists. Table 2 shows the distribution of projects by sector characteristics and by type of contract. The data span a variety of sectors and services with very different economic or infrastructure characteristics. Network transportation and water are prevalent in the data, representing 26.5 and 31 percent of the sample respectively. There are, however, a significant percentage of projects in stand-alone facilities and non-network transportation sectors like ports and airports. These projects are governed by different contract types. Management contracts (23 percent) and BOT-type contracts (31 percent) are the most frequent. There are, however, several other contract types in the sample, such as design-build (15 percent), concessions (7 percent) and leveraged agreements (19 percent). Asset sales (1 percent) and joint development agreements (3 percent) are much less important.

Table 1
Description of the International Major Projects Survey 2008 for the United States. Sectors and Services included

	Sectors and Services	Sector Characteristics
1	Roads	Network Transportation
2	Rail	Network Transportation
3	Airports	Non-Network Transportation
4	Ports	Non-Network Transportation
5	Water	Water/Network Services
6	Prisons	Stand-alone Facilities
7	Housing	Stand-alone Facilities
8	Post Office	Stand-alone Facilities
9	Schools	Stand-alone Facilities
10	Waste	Stand-alone Facilities
11	Parking	Stand-alone Facilities
12	Military Housing	Non-Network/Military
13	Street Lights	Other
14	Space Flight centers	Other
15	Sports	Other
16	Shuttles	Other

Source: International Major Projects Survey 2008, *Public Works Financing.*

[12] Unfortunately, missing information on some characteristics prevents us from using a non-trivial share of this sample, as will be shown in the results section.

Table 2
The distribution of projects according to sector characteristics and type of contract in the 2008 *International Major Projects Survey*

Characteristics	Nº	% of sample		Contract Types	Nº	% of sample
Network Transportation	125	26.5		Management Contracts	109	23.1
Non Network Transportation	29	6.1		Leverage	91	19.3
Water Sector/Network Services	170	36.0		Joint Development	14	3.0
Facilities	61	12.9		Concession	34	7.2
Military	78	16.5		Asset Sale	5	1.0
Other	9	1.9		Design and Build	72	15.3
	472	100		BOT Type contracts [1]	147	31.1
					472	100

Source: International Major Projects Survey 2008, *Public Works Financing*.
1. This group includes the following contracts: BOT, BOO, BOOT, BTO, DBFO, DBO, DBM, DBOM, DFBO, etc.

4.2. Dependent Variables

We next discuss the dependent variables in our data set. We divide our dependent variables into two types: a four-category ordered contract variable and a binary contractual variable. We discuss each in turn.

4.2.1 Ordered Contract

This is an ordered categorical variable that assigns low values to projects with low private involvement (and consequently low private risk assumption), and high values to projects with higher private participation. In Table 3 we present the type of contracts and values designated according to the extent of private involvement.

Table 3
Categorical dependent variable

Type of contract	Private involvement	Risk Sharing
Design and Build	1	VERY LOW
Management Contracts	2	LOW
Concessions and BOT-type Contracts	3	HIGH
Asset Sale	4	VERY HIGH

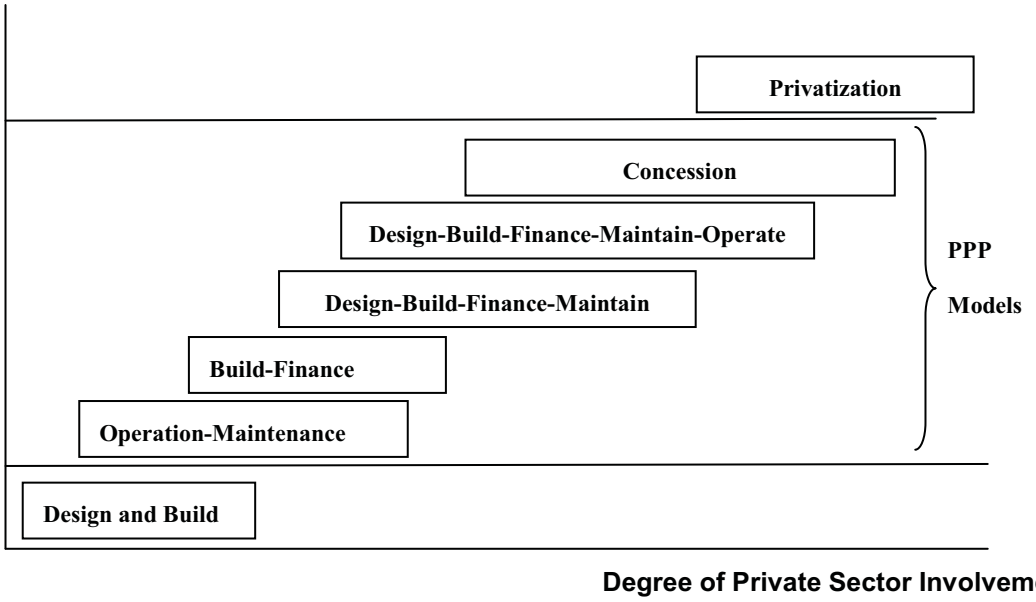
Design and built (DB) contracts receive the lowest value. The private partner designs and constructs but does not operate the infrastructure. Although DB contracts involve relatively large initial investments, and the private partner may face risks encountered in construction and design, the private partner does not assume demand risk, so they are relatively low-risk in the spectrum of contracts. The unique difference between Design-Build contracts and traditional procurement for construction is the responsibility of the private partner in the link between design and construction. Therefore, there is a larger transfer of responsibility from the public to the private sector. However, the contractor does not bear demand risk. The next level of private involvement is management contracts. In these contracts, private operators simply manage existing infrastructure, such as Terminal E in Atlanta, and few if any new investments are employed. Although these contracts are subject to demand risk, the overall level of risk for the private partner is low.

Concessions and build-operate-transfer (BOT) contracts are the next category, receiving a value of three. Under a BOT approach, the private partner builds and operates the facility for a pre-specified time period. Transfer of facility title back to the public sponsor occurs at the end of that period. Under this approach, the private partner typically assumes substantial risk associated with the facility's construction and operation, such as demand risk.

The final category is the asset sale. In this type of contract, the private partner actually acquires title to the facility, and assumes all attendant risks associated with its ongoing operation, maintenance and refurbishment. We assign this category a value of four, which reflects the highest degree of private involvement and risk assumption.

Our categorization of contract types, which combines the degree of private involvement and the level of risk assumed by the private partner, is relevant for public policy. It is consistent with categorizations made by institutions such as the Asian Development Bank (ADB, 2008) and the United Nations (UNECE, 2008), among others. Figure 1 illustrates this with the classification proposed by the Canadian Council for Public-Private-Partnerships.

Figure 1. Risk transfer and Private sector involvement by contract type



Source: *Models of Public-Private-Partnerships.* The Canadian Council for Public Private Partnerships (http://www.pppcouncil.ca/resources/about-ppp/models.html Accessed on August, 30th, 2012)

4.2.2 Binary Contract

Both management and DB contracts carry significantly lower levels of risk relative to asset sales or concession/BOT-type contracts. We thus created a dummy variable assuming a value of zero if the project is a DB or management agreement. This variable is assigned a value of one for all other contract types, in which we include concession and BOT-type agreements (DBFO, DBO, DBM, BOO, DBOM, etc.), as well as asset sales. This variable thus captures contracts with a high degree of private involvement, and therefore large private investment and risk assumption.

4.3. Independent Variables

We next discuss our independent variables, categorizing them into fiscal variables, political variables, economic characteristics, basic controls, and regional dummy variables. We discuss each in turn, and provide a definition of the variable with its interpretation and anticipated effect.

a) Fiscal variables

Tax Burden: Tax revenues divided by income in the state where the project is signed in the year *prior* to the agreement. This variable controls for fiscal pressure and the ability of governments to raise money from taxpayers in a given state. We expect this variable to be negatively correlated with the level of private involvement through the project because states with larger revenues are likely to be less reliant on private investment. The source for this variable is The Tax Foundation's tables entitled "State and Local Tax Burdens: All Years, One State 1977-2008."[13]

***Debt Stress*:** State debt outstanding (in millions of current dollars) divided by state income in the year prior to the project agreement. This captures states with fiscal stress resulting from relatively high debt levels. We expect a positive relationship between *Debt Stress* and private participation in projects. In this case, public officials seek private sector participation to help address fiscal constraints. The data source for this variable is the Statistical Abstract of the United States, Tables entitled: *"*State and Local Governments -- Expenditures and Debt by State*"* *(various years).*

[13] Available at: http://www.taxfoundation.org/research/topic/9.html (accessed August 29, 2012).

***Bond Rating*:** Current-year Standard & Poor's State Bond Rating, where alphabetical rankings are converted into a numerical index. States with higher ratings can obtain bond financing at lower cost than those with low ratings, thus lowering the cost of traditional infrastructure financing. Such states will be less in need of private participation. This suggests a negative effect of a state's bond ratings on the level of private participation. We use Standard and Poor's ratings of state-issued debt.

***Contract Size*:** Project size (or cost) in thousands of U.S. dollars divided by the region's gross domestic product. Inexpensive projects can be undertaken by states with even modest resources. Moreover, administrative costs generated by long-term contracts where different aspects of the services are bundled are large and tendering periods are long. Because of this, for example, the U.K. Treasury currently considers PFI projects of less than UK£ 20m as poor value for money (HM Treasury, 2006). Instead, expensive projects might require private participation in order to share investment costs and/or risks. We thus expect a positive effect of project cost on the degree of private involvement. The data source for this variable is the monthly newsletter Public Works Financing.

b) Economic efficiency and network effects

***Network*:** A binary variable assigned a value of one for road, rail, and water projects, zero otherwise. These industries enjoy network characteristics and are usually defined as natural monopolies. They are associated with sunk investments, larger transaction costs, and lower levels of competition. Smaller efficiency gains are therefore expected from private participation in these projects. We expect network characteristics to have a negative effect on the degree of private participation. The data source for this variable is Public Works Financing.

***Point-to-Point (non-network transportation)*:** A binary variable assigned a value of one for port and airport projects, zero otherwise. This type of transport infrastructure does not belong to a network and is usually operated as a stand-alone entity, facing varying degrees of competition. We expect larger efficiency gains from this type of private involvement. We predict that this variable will positively impact the extent of private participation in projects. The data source for this variable is Public Works Financing.

***Facilities*:** A binary variable set to one for prisons or post office projects, zero otherwise. Similar to the previous variable, we expect efficiency gains from private involvement. We thus predict that there will be a positive relationship between *Facilities* and the extent of private participation in projects. The data source for this variable is also Public Works Financing.

Others: A binary variable set to one for a miscellaneous set of projects such as parking garages, waste treatment facilities, and shuttles, zero otherwise. This combines all projects not included in the previous three variables. Regarding the network vs. non-network characteristic, these are stand-alone projects that are typically not part of a network. We thus expect this variable to have a positive impact on the degree of private involvement in projects. The data source for this variable is Public Works Financing.

***Public Servants pc*:** State and local full-time public employees (in thousands) per inhabitant in the year in which the project was signed. Public servants per capita measures the likely intensity of public labor opposition to private involvement. However, it is also indicative of greater potential cost savings derived from private management of labor and assets. We use this variable to account for the size of the public sector labor force. The source for this variable is the Statistical Abstract of the United States, Tables entitled: "State and Local Governments -- Expenditures and Debt by State" (various years).

c) Political variables

***Republican legislature*:** Share of votes cast for the Republican Party in the state legislative election prior to the project agreement. This political sentiment variable captures a business friendly and general market orientation associated with the Republican Party. Democrats may be predisposed to use public resources, while Republicans may be more likely to rely on the private sector. The data source for this variable is Michael Barone's Almanac of American Politics (various years).

***Republican Governor*:** This is a dummy variable assigned a value of one if the governor in place when the project is signed is Republican, zero otherwise. Similar to the above, we expect that Republican governors will be more business friendly and more market oriented than Democratic governors. The data source for this variable is also Barone's Almanac of American Politics (various years).

d) Control variables

***Income pc*:** State income per capita in constant 2009 U.S. dollars. We use constant dollar terms in order to avoid problems related to time and inflation in a pooled sample composed of projects signed in different years. Citizens' purchasing power in a state will positively influence private investors' decisions regarding how much to invest, particularly for user-funded projects. However, users are also taxpayers, and richer areas are likely to provide more public funds – through greater tax revenue – that will help in undertaking public investments. Alternatively, richer areas may be more attractive to private investors. More public funding is likely to lead to lower private involvement in projects. Therefore, we do not have a clear prediction for the effect of this variable. The source for this variable is The Tax Foundation's, tables entitled *"*State and Local Tax Burdens: All Years, One State 1977-2008.*"*[14]

***Population*:** State population (in thousands). This variable captures the size of the market where the project is signed. Private investors are likely to be more interested in providing facilities in highly populated markets. We expect that larger state populations will result in greater private involvement. The data source for this variable is the Statistical Abstract of the United States, Tables entitled: "State and Local Governments -- Expenditures and Debt by State*"* *(various years).*

***Sponsor*:** Categorical variable assigned a value of one if the project sponsor is a local government, two if a state government and three if the federal government. Higher levels of government typically receive more public resources, so we expect a negative impact of this variable on the degree of private participation in projects. The data source for this variable is Public Works Financing.

[14] Available at: http://www.taxfoundation.org/research/topic/9.html.

e) Regional variables

D^{West} : Dummy variable assigned a value of one for states in the U.S. census region designated as "west," zero otherwise.

$D^{Northeast}$: Dummy variable assigned a value of one for states in the U.S. census region designated as "northeast," zero otherwise.

D^{South}: Dummy variable assigned a value of one for states in the U.S. census region designated as "south," zero otherwise.

$D^{Midwest}$: Dummy variable assigned a value of one for states in the U.S. census region designated as "midwest," zero otherwise.

5. Estimation Strategy

We use different models to evaluate the impact of fiscal, political, economic and control variables on the extent of private participation in completed projects. These considerations affect our choice of econometric model. Our sample is a pool of projects signed in the United States between 1985 and 2008. We cannot follow particular projects across time however.

Given the limitations of OLS for discrete and binary dependent variables, our main estimates utilize ordered logit and standard logit models, where estimates are robust to heteroskedasticity for ordered categorical discrete variables (*Ordered contract*) and binary variables (*Binary Contract*), respectively.[15] Indeed, the literature on privatization has focused more on the decision of whether to privatize (contract out) or not, which has expanded the use of logit and probit models in this field. One of our key contributions in addition to the new approach we take to studying privatization – the extent of private participation once the contracting out decision has been made – allows us to use models that consider different privatization intensities. We utilize models applicable to categorical ordered discrete dependent variables.

[15] However, the use of ordered logit also introduces some limitations due to its underlying assumptions. It assumes a monotone one dimensional relationship between the latent and unobserved variables.

We use an ordered multinomial logistic model to estimate private participation in contracts (*Ordered Contract*). The ordered logit model is based on a continuous latent variable specified as a linear equation in (1):

$$y_i^* = \beta' x_i + \varepsilon_i \ , \quad -\infty < y_i^* < \infty \qquad (1)$$

where y_i* (unobserved) measures the degree of private participation in the contract, x_i is a vector of factors explaining y_i*, with associated parameters β. The error term ε indicates the effect of all unobserved factors on y_i*. Assuming that y_i is the observed discrete variable reflecting different levels of private involvement for project *i*, the relationship between the latent variable and the observed variable is obtained according to:

$$y_i^* = 1 \text{ if } -\infty \le y_i^* < \mu_1 \ i = 1...., n. \qquad (2)$$

$$y_i^* = 2 \text{ if } -\infty \le y_i^* < \mu_2 \ i = 1...., n.$$

$$y_i^* = 3 \text{ if } -\infty \le y_i^* < \mu_3 \ i = 1...., n.$$

... ...

$$y_i^* = J \text{ if } \mu_{J-1} \le y_i^* < \infty \ i = 1...., n.$$

The μ's are the estimated thresholds where the discrete observed responses are defined. This model estimates the probability that project *i* sustains private involvement of level *j* or lower (*j−1,…,1*). The model specification is:

$$\log\left[\frac{\gamma_j(x_i)}{1-\gamma_j(x_i)}\right] = \mu_j - \left[\beta_1 x_{1i} + \beta_2 x_{2i} + ... + \beta_K x_{Ki}\right], j = 1,....,n \qquad (3)$$

where γ_j is the cumulative probability, β is the vector of parameters ($\beta_1, \beta_2, \ldots, \beta_K$) and x_i is the vector of regressors. Parameter estimates are obtained by maximum likelihood.

The first specification of the above models (Specification 1 below) considers all variables (except regional dummies) that could be correlated with fiscal, political and demographic variables.[16] In contrast, Specification 2 includes regional dummies, where southern states are the omitted category. We apply ordered logit and logit models to both specifications.

[16] In fact, we find some large pair correlations between the dummy variables $D^{Northeast}$ and D^{South} with fiscal variables like *Debt Stress*.

Specification 1

$$Contract_i = \propto + \beta_1 Taxburden_i + \beta_2 Debt\_Stress_i + \beta_3 Bond\_Rating_i + \beta_4 Contract\_Size_i + \beta_5 Point\_Infrastructure_i + \beta_6 Facilities_i + \beta_7 Other_i + \beta_8 Public\_Servants_i + \beta_9 Republican\_Legislature_i + \beta_{10} Republican\_Governor_i + \beta_{11} Income\_pc_i + \beta_{12} Population_i + \beta_{13} Sponsor_i + \varepsilon_i \quad \textbf{(4)}$$

Specification 2

$$Contract_i = \propto + \beta_1 Taxburden_i + \beta_2 Debt\_Stress_i + \beta_3 Bond\_Rating_i + \beta_4 Contract\_Size_i + \beta_5 Point\_Infrastructure_i + \beta_6 Facilities_i + \beta_7 Other_i + \beta_8 Public\_Servants_i + \beta_9 Republican\_Legislature_i + \beta_{10} Republican\_Governor_i + \beta_{11} Income\_pc_i + \beta_{12} Population_i + \beta_{13} Sponsor_i + \partial D^{North\_east} + \partial D^{Midwest} + \partial D^{West} \varepsilon_i \quad \textbf{(5)}$$

We applied a specification error test and a multicollinearity diagnostic to these models, which generate satisfying results.[17] The first test for specification error (*linktest* in STATA) shows the meaningfulness of the covariates chosen, the absence of omitted variable bias, and a correct assumption for the specified link function. The second test for multicollinearity (variance inflation factors) finds no significant collinearity in our specification.[18]

[17] Linear predicted *p-value* = *0.000* and squared predicted *p-value* = *0.213*
[18] Variance Inflation Factor (VIF) = *1.61* < *10* (Rule of thumb)

6. Model Estimation

Our main estimates are displayed in Table 4 below. Columns 1 and 2 report estimates without regional variables. Generally, all variable groups (except the political group), display significant coefficient estimates. Fiscal variables, infrastructure-type variables, and controls all contribute to determining the intensity of private participation in the contract. This is consistent with joint tests of the significance of the major variable groups. The *p*-values for significance tests for fiscal variables is 0.04, for political variables it is 0.21, for infrastructure type it is 0.00, and 0.00 for controls.

Within the fiscal variable category, tax burden and debt stress display the expected negative and positive signs, respectively, and both appear statistically significant with and without regional dummies in the specification (restricted and extended models). In the case of the bond-rating variable, we do not find any significant relationship with contract type. Regarding contract size, we do not find statistical significance for specification 1, in which we apply the ordered logit models without regional controls. We obtain the same finding when we apply the logit model in which we change the dependent variable from a categorical ordered variable to a binary variable. We interpret this result as driven by the fact that contract size alone does not relate to contract-specific risks. For instance, a large contract with no demand risk may be more appealing for private contractors than small contracts with demand risk.

Our main focus is on the infrastructure characteristics of the sector in question and their importance for the degree of private participation. Because we use the contracts for network infrastructure (water, road and rail) as a reference category, we compare results for the other sectors to this base category. The coefficient associated with the binary variable of point-to-point transport infrastructure (airports and ports) is highly significant and positively related to the extent of private participation. Similar results are obtained for the coefficient associated with *Facilities*. Marginal effects are presented in Table 5 for the logistic estimation in order to provide a magnitude of the effect found. The first column (min→max) shows the estimated change in predicted probability as *x* changes from its minimum to its maximum. The second column displays the partial derivative (instantaneous change) of the predicted probability/rate with respect to a given independent variable.

Hence, contracts with larger private participation and private risk assumption appear more frequently for those infrastructure types and in those facilities *not* displaying network characteristics. In addition, their coefficients show how these properties play a central role in project involvement. This confirms our main hypothesis: network attributes are a key determinant of the extent of private participation. This is consistent with previous literature on the influence of transaction costs and limited expected efficiency gains with private delivery of public services.

According to our estimates, political variables do not explain contract choice, supporting arguments about the pragmatic origins of the private participation decision rather than an ideological position. Regarding controls, the coefficient associated with the number of public servants per inhabitant is statistically significant across models. According to our estimates, jurisdictions with more public servants tend to sign contracts with larger private participation, perhaps due to the potential cost savings associated with the private management of labor and asset resources. Population is only significant in the logistic regression, although it appears significant at 5 percent, showing a positive and strong correlation between the number of inhabitants (and therefore potential users or customers, i.e. market size), and private involvement.

Finally, sponsor's level of government (local, state, or federal) affects private participation. There is more private involvement in projects sponsored by local governments than by their federal or State-level counterparts. The high statistical significance is consistent across restricted and extended models and different estimation strategies. The other control variables do not show any statistically significant relationship with contract choice.

The introduction of regional variables (extended model) in specification 3 leads to similar conclusions.[19] The partial correlation between these variables and some fiscal variables affects their coefficients. However, most of the previous results are unchanged, particularly in the case of infrastructure or service characteristics. In fact, none of these variables seem to explain by itself (*ceteris paribus*) changes in the contract decision, so we do not find regional patterns. As a result, differences in the regional choice of contracts could be mainly related to a jurisdiction's fiscal characteristics.

[19] We do not perform logistic regressions extending the standard model with regional variables because these variables do not add anything to the explanatory power of the model and do not appear statistically significant. The other coefficients behave consistently after their inclusion, with the exception of fiscal variables, as happens in the ordered logistic model.

Table 4

Ordered Logistic and Standard Logistic Estimates for Type of Contract

Regressors	**Ordered Logit (1)**	**Logit (2)**	**Ordered Logit (3)**
Fiscal Variables			
Tax Burden	**-0.2405**** **(-2.03)**	**-0.2841**** **(-2.19)**	-0.2241 (-1.65)
Debt stress	**0.0751*** **(1.84)**	0.0673 (1.54)	**0.0700*** **(1.72)**
State Bond Rating	0.0732 (0.53)	0.1269 (0.91)	0.602 (0.42)
Contract Size	0.0497 (0.18)	0.0413 (1.39)	0.0101 (0.36)
Efficiency and type of infrastructure *(Base Category: Network)*			
Point to Point	**2.141***** **(3.93)**	**2.6021***** **(2.84)**	**2.145***** **(2.80)**
Facilities	**1.959**** **(2.43)**	**1.8834***** **(2.62)**	**1.940***** **(3.80)**
Other	**2.037***** **(4.09)**	**1.5433*** **(1.68)**	**2.116***** **(3.84)**
Public Servants pc	**8.03e-07*** **(1.78)**	**4.82e-07** **(1.50)**	**7.65e-07*** **(1.70)**
Political Variables			
Republican Governor	-0.2233 (-0.83)	-0.4525 (-1.56)	-0.2546 (-0.87)
Republican Legislature	-0.8388 (-0.54)	-1.6364 (-0.85)	-1.080 (-0.67)
Control Variables			
Income pc	0.00001 (0.58)	-2.98e-06 (-0.13)	0.00001 (0.58)
Population	0.0001 (1.56)	**0.0001**** **(2.53)**	0.00003 (1.56)
Sponsor	**-1.143***** **(-3.49)**	**-0.8539***** **(-2.68)**	**-1.149***** **(-3.51)**
Regional Variables			
North East		-	-0.0834 (-0.18)
Midwest		-	-0.2124 (-0.49)
West		-	0.2246 (0.47)
N. Observations	280	280	280
Pseudo R2	0.08	0.13	0.09
Log Likelihood	-267.55	-169.02	-264.41
Wald (Chi2)	37.25***	47.51***	34.44***

Note: Robust- to- heteroskedasticity *Z*-statistics in parentheses. * significant at 10%, **5% and *1%, respectively.

Table 5
Changes in Predicted Probabilities for Contract Choice.

Regressors	min->max	Marginal Effect
Point to Point	0.4050	0.6420
Facilities	0.3604	0.4647
Other	0.3003	0.3808

7. Summary and Conclusions

To our knowledge, ours is the first attempt to examine the determinants of the choice of contract types across a range of economic sectors. This is an improvement over the traditional approach examining a binary public versus private decision. Study of the extent of private involvement in projects across sectors offers the first evidence about the role of fiscal, political and infrastructure-type characteristics in driving the degree of private involvement. With that goal in mind, we focus on four types or groups of contracts in the United States, representing an increasing role for private participants and a greater transfer of risk to private partners: simple design-and-build contracts, management contracts, BOT-type contracts, and asset sales.

We examined several variable groups that may affect contract choice, including fiscal and political variables. However, our main focus is on the role played by variables measuring whether or not the infrastructure in question is part of a network. Indeed, this characterization of single versus network infrastructure is a leading driver of private participation: private involvement is more likely in the case of point-to-point infrastructure and facilities, and less likely for network infrastructure. The estimated effect of switching from network to stand-alone or point-to-point is substantial.

Our models indicate that the probability of having large private involvement in single projects is much larger than in network infrastructure. This effect remains after controlling for a variety of additional factors in our analysis, such as fiscal, political, management, and control variables, among others.

These findings have important implications for public policy. They are consistent with the general observation that network infrastructure is associated with sunk investments, larger transaction costs, and lower levels of competition. Smaller efficiency gains from private participation may be expected in such cases, which may help explain why private involvement is limited in these project types. Our findings also suggest that jurisdictions new to this type of contracting may have a better initial experience with facilities or point-to-point infrastructure, and should begin with those. However, further theoretical research is necessary to better understand this relationship.

Political variables do not explain a significant portion of the extent of private involvement in projects, but we do find that fiscal variables are, as a group, an important determinant, and that a jurisdiction's level of debt-stress is an important driver of the level of private involvement in contracts, as is the jurisdiction's tax burden. In addition to other control variables, our model permits a preliminary assessment of the origins and explanations behind how governments choose the level of private involvement in contracts. This is a step beyond the standard approach of focusing on a binary privatization decision, and hopefully improves our understanding of the specific forms of relational agreements between government project sponsors and private sector partners.

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