Do State Fiscal Constraints Affect Implementation of Highway Public-Private Partnerships? A Panel Fixed Logit Assessment

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Infrastructure public-private partnerships ("P3s") have gained considerable recognition as useful policy tools for state and local governments to deliver critically needed infrastructure projects. The objective of this study is to empirically test one of the claims often made regarding states' motivations for employing this procurement mechanism: P3s can help overcome fiscal constraints on state infrastructure investment. In addition, this study empirically analyzes how state P3 enabling legislation affects the behavior of both the public and private sectors. A regular logit model and a fixed effects logit panel model are employed to test the hypothesis that states with more severe fiscal constraints are more likely to seek P3s for highway infrastructure construction and finance. After controlling for such factors as state economic condition, legislative political affiliation, and highway travel demand, the empirical results indicate that states' fiscal constraints are not associated with the propensity to use highway P3 projects.

INTRODUCTION

Infrastructure public-private partnerships ("P3s") have gained considerable recognition as policy tools for state and local governments to improve efficiency in delivering infrastructure that is critical for economic development. The U.S. Federal Highway Administration (FHWA) defines P3s as "contractual agreements formed between a public agency and private sector entity that allow for greater private sector participation in the delivery and financing of transportation projects" (FHWA Office of Innovative Program Delivery 2013). Scholars have argued that P3s could be justified on the basis of the potential for easing fiscal constraints on the public sector through access to the private sector's innovative cost-saving practices and financial resources.

The focus of policy debate regarding transportation P3s has been on developing the capacity among state transportation agencies to implement P3 programs and projects. DeCorla-Souza et al. (2013a) suggest key factors of capacity include: statutory and policy frameworks, a pipeline of potential P3 projects, procurement system adequacy, and oversight mechanism adequacy.

Questions such as whether and how P3s can enable cost savings through infrastructure delivery and overcome fiscal constraints of public agencies have been widely discussed and debated (Välilä 2005). Due to the limited number of P3 projects, however, *ex post* analyses on whether the presumed benefits have been achieved are limited, particularly in the U.S. context (U.S. Congressional Budget Office 2012).

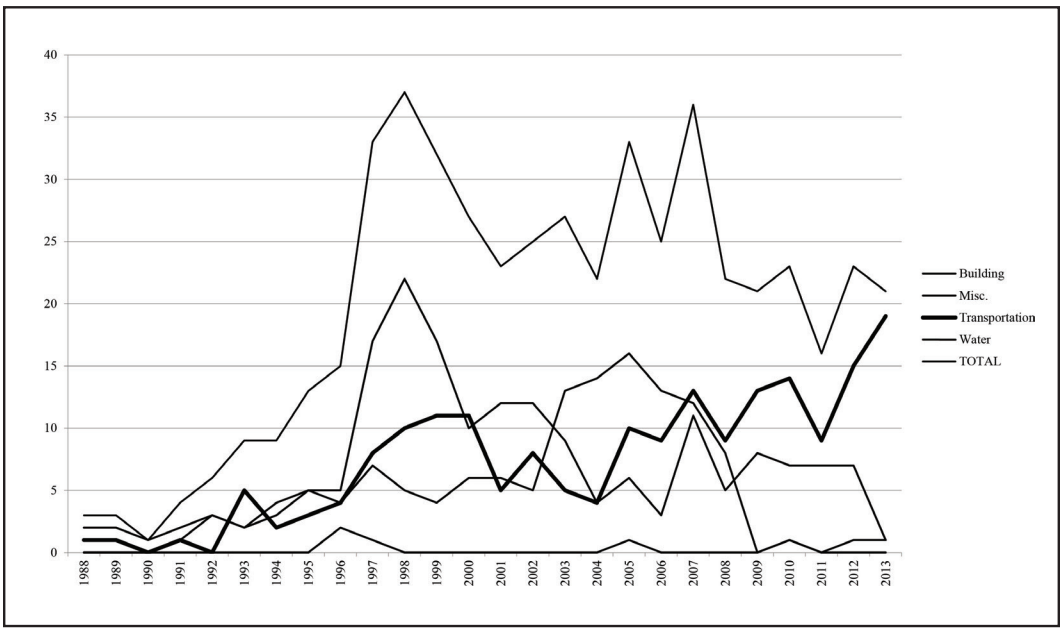
Since few studies have empirically tested whether P3s are employed more extensively by state authorities with particular fiscal circumstances or not, the objective of this study is to empirically test one of the claims often made regarding states' motivations for employing this procurement mechanism: through opening access to private capital, P3s could help public authorities overcome their fiscal constraints for investing in infrastructure. The paper also investigates how the enactment of P3 enabling legislation may affect the behavior of both public and private sectors. By addressing these empirical questions, this study intends to shed light on the state of the practice of P3s in highway finance.

The rest of this paper is structured as follows. The second section reviews the background and relevant literature. The third section presents the data used in the analysis. The methodology of the analysis is discussed in the fourth section, which is followed by a discussion of research findings in the fifth section. The last section summarizes and concludes.

BACKGROUND

P3s have become a popular procurement mechanism in the United States not only in the transportation sector but also in other sectors, such as water/wastewater, prison, and government buildings (Figure 1). The aggregate number of P3s in all sectors that reached financial closes emerged and soon dramatically increased in the 1990s. In the 2000s, the number of P3s fluctuated due in part to the financial crisis in 2008. While water and general building P3s decreased during the 2000s, the number of P3s in the transportation sector has shown steady growth to date.

Figure 1: Number of U.S. P3 Financial Closes by Sector, 1988-2013



Note: Transportation sector numbers encompass all P3 contract types, including leases and management contracts.
Source: *Public Works Financing* Newsletter Database.

In the context of highway capacity expansion projects in the United States, the traditional procurement model is referred to as design-bid-build model (DBB). A highway construction project has multiple components, such as design, construction, operation, and maintenance. A public agency is the owner of the asset to be built, and the agency is responsible for funding the project. Certain stages of the project will be contracted out to a private firm to do the job: design can be done either by in-house engineers or contracted to an engineering firm; construction is usually done by a private contractor; and the completed highway asset can be maintained by in-house staff or contracted to a private firm specialized in the service.

While this model can ensure accountability of each project stage and achieve transparency, it may not be the best approach to achieve cost efficiency, which is a growing concern under the tight budget conditions of government agencies. In this traditional DBB model, the contractor for each stage has the incentive to minimize its cost, possibly at the cost of another stage of the project. If

there is a discrepancy between design specifications and the actual site condition, the process to reflect the site condition on the blueprints, obtain necessary approvals, redevelop a construction strategy, and do the job could easily lead to cost and schedule overruns. Under such scenarios, the public agency may bear the responsibility of the potentially significant costs of these changes.

Design-build contract (DB) evolved to address design risks as follows: by contracting both design and construction phases, change-orders may decrease considerably. In this contract, the design risk has been transferred to the private contractor. Thus, some may argue that the DB contract can be considered a form of P3s (Congressional Budget Office 2012). By incorporating the project's maintenance stage to the contract, the cost savings of project bundling could be extended further. When the operation and management stages of the project are bundled to the DB contract (hence, a design-build-operate-maintain, or DBOM, contract), the private partner would be incentivized to optimize the life-cycle cost of the project. For example, the partner may choose a design specification of the asphalt such that the initial construction may be more costly but the life-cycle cost will be more cost efficient.

If the financing arrangement is also bundled to the contract, involving private equity investment to the project, then a design-build-finance-operate-maintain contract (DBFOM) is used. In this case, project finance arrangement is made for the private partner to finance the initial capital investment of the project. Project finance is a financial technique used to finance projects that involve large upfront capital investment (e.g., power plant, water plant, highway).

In this model, the initial investment is realized by combining equity investment from companies participating in the project (e.g., contractor, operator, designer, and investor) and debt financing (e.g., bank loan and bond). Revenues from the project will be used to repay the debt obligation and for operational and maintenance expenses, and the remainder will be the profit, which is equivalent to the return on the equity investment. Multiple private companies form a legally independent project specific entity (Special Purpose Vehicle, or SPV) solely for providing the service defined in the project, such as design-build, operation, and maintenance. Importantly, since the SPVs are legally distinct from participating firms, lenders will make their lending decisions based not on the general credit and firm-wide cash flow but on the conditions specific to the project.

The economic advantage of P3s has been found on the basis of the incomplete contract theory framework (Välilä 2005). In this line of thought, the emphasis is on bundling of project components and transfer of project risks from the public authority to a private partner, as well as the costs of implementing such complex contractual transactions. Hart (2003) first formalized the P3s' cost efficiency through bundling of project components and suitable project risk allocation based on incomplete contract theory framework. In this model, procurement approaches have distinct implications for contractors in terms of incentives for cost savings. Hart predicted that a traditional DBB model would be desirable when construction of the building can be well specified while the quality of the service cannot be well specified. P3 procurement might be more efficient when the service quality can be well specified in the contract while the quality of the initial construction could not be well specified.

Martimort and Pouyet (2008) extended the analysis by focusing on the externality of one project stage to the others and the asset ownership. In this context, a positive externality of production is present when, for example, building specification is such that the operational/maintenance costs become more efficient (e.g., more costly high specification of asphalt lowers the maintenance costs during the operational phase). Their model showed that when it is costly to specify service requirements in the contract, transferring the ownership to the private contractor would incentivize the private partner to exert its best effort to increase the asset value through lowering its costs of production (Martimort and Pouyet 2008). Bennet and Iossa (2006) showed that, when a positive externality is present, ex ante incentive for cost saving and quality service is stronger if, after the contract life the asset is to be under the ownership of the private partner. The authors argued that based on this finding that the P3s may not be a preferable model in sectors against which there is

strong resistance, political or otherwise, for long-term private ownership (Bennet and Iossa 2006). De Bettignies and Ross (2009) compared public financing and private financing of public infrastructure projects, based on the industrial organization and corporate finance theories. The authors argued that private borrowing might be ex-post superior to public borrowing, because private developers would be willing to commit to smaller debt and repayment obligations with high expected returns. In this view, financially unviable projects would not materialize due to the lack of willingness of private lenders and developers. Public agencies might continue with the investment in projects with smaller expected financial returns for economic development, policy, or political motives, but only with public financing arrangements.

Project finance arrangements are made for infrastructure projects that involve private financing. Brealey et al. (1996) explored theoretical justifications of employing project finance techniques for infrastructure projects, and how both the public sponsor and the private partner might benefit from it. They point out that a commonly held notion that the cost of capital might be cheaper for governments could be misleading, since the lower interest rates merely reflect the risks borne by taxpayers. They argue that the benefit of project finance for infrastructure projects might be found because they allow bringing in the expertise of cost savings and efficient management of certain risks by the private firms, while avoiding full "privatization." This is so because privatization would entail designing complex new regulatory institutions, which may be inappropriate for certain sectors such as education (Brealey et al. 1996).

Variations of P3 contracts include design-build-operate contracts (DBO), design-build-finance (DBF), which involves short-term financing by the private partner, design-build-maintain (DBM), and so forth. These capacity expansion projects can be considered as an extension of the traditional construction projects, involving agreed compensation from the public procuring authority to the private partner.

On this theoretical foundation, a P3 procurement model is ex-ante preferred if the transaction costs of employing the model (e.g., legal, financial, consulting, and other fees) are smaller than the cost savings achieved by employing the P3 model. In other words, deciding the procurement model requires comparing the life cycle costs of the P3 approach and the alternative public procurement model. The topic of ex-ante decision models has received policy attention in the United States in recent years (DeCorla-Souza et al. 2013b). In countries such as the United Kingdom (U.K.), Australia, Canada, and the Netherlands, value for money (VFM) analysis is considered an established evaluation framework, primarily due to their extensive experiences with P3 mechanisms for various projects. This is particularly so in the U.K., where the Private Financing Initiative (PFI) employed VFM analysis, which is defined as "the optimum combination of whole-of-life costs and quality (or fitness for purpose) of the good or service to meet the user's requirement" (HM Treasury 2006). Likewise, a P3 business development guidebook published by the Canadian government defines VFM with specific components to be used for project evaluation (Burr et al. 2011).

In the United States, the use of VFM for P3 project evaluation is still in its infancy. A survey of state officials found that only 30% of the responding states use some sort of methods to evaluate P3 alternatives for a project (16 states responded out of 22 states contacted). These analyses are often in-house, and currently there is no standard VFM used for P3 projects (Morrallos et al. 2009).

In recent years, dissatisfaction about the lack of a VFM standard led to active academic and policy debate on P3 project evaluation methods in the United States. DeCorla-Souza et al. (2013b), for example, discussed concerns associated with the use of VFM in its present form. They argued that VFM focuses only on the financial aspect of infrastructure projects, and fails to account for societal benefits or costs of a project. One of the benefits of P3s in the United States is their faster project delivery through access to private capital. They point out that what should be compared in typical situations are a P3 alternative and delayed public provision due to the fiscal constraints of the public sponsor. VFM fails to account for such benefits (DeCorla-Souza et al. 2013b). Overall, the emphasis of policy debate regarding the infrastructure P3s is on improving the state of the practice

with enhanced knowledge and experience regarding the use of P3s by state and local governments in delivering transportation infrastructure.

Another important subject of policy discussions is ex-post evaluation of P3s' performance, which has been limited to date. This is in part due to the shortage of experiences in the United States (U.S. Congressional Budget Office 2012). Hodge (2010) argued that whether these projects had actually achieved the theorized cost saving benefits was still empirically unsettled, noting that rigorous empirical analysis or meta-analysis had been very limited or of questionable quality, and only narratives and anecdotal information was available. Few studies include empirical analysis with statistical rigor. Blanc-Brude et al. (2006) compared the cost differences of P3s and publicly procured highway projects that received funding from the European Investment Bank (EIB), using confidential project documents. They tested the hypothesis that P3s would demonstrate higher costs because of the premium of the risks transferred to the private partner and the engineering specifications designed to optimize life cycle cost saving. The analysis found that the construction costs of P3 projects were 24% higher than publicly procured projects, supporting their hypothesis. Dudkin and Välilä (2006) estimated the difference between P3s and publicly procured infrastructure in terms of their transaction costs for establishing and maintaining a partnership, including legal, financial, and technical advisory costs. Because of the small number of samples, they conducted nonparametric statistical tests to investigate if samples came from the same population in terms of their means. They found that the P3 projects were on average 10% more costly than publicly procured projects with regard to their transaction costs (Dudkin and Välilä 2006).

While the economic rationale of P3s and their performance evaluation is an important policy consideration, in this study we are interested in fiscal, institutional, and political considerations behind the decisions of procurement model alternatives. The next section will review relevant literature on this subject.

LITERATURE REVIEW

From an institutional perspective, there have been several studies that investigated the factors affecting the likelihood of governments employing P3 arrangements for infrastructure investments in the international context. Because the factors considered under the realm of institutional and political conditions are broad, we develop hypotheses of empirical specifications based on the literature, rather than analyzing through a formal mathematical model. Checherita (2007) demonstrated that the decision of a country to invest under a P3 arrangement depends on such factors as macroeconomic, political, and financial risks; exogenous economic shocks; and the size of overall government spending (Checherita 2007). Empirical studies have also found that a number of factors, including the magnitude of economic activities, sovereign debt, macroeconomic stability, and presence of stable legal and institutional framework, are associated with the size of P3 projects in a country (Hammami et al. 2006). International comparisons of P3 markets have presented challenges for scholars because of the variety and complexity of these schemes across nations, and limited project-level data on P3 institutions.

The United States is a unique case to analyze P3 institutions, since the market in each state is distinct from those of other states. Few studies have been conducted to address questions on P3 institutions focusing on the specific context of U.S. states. It has been argued that P3 enabling legislation is an essential first step for states implementing P3s and allowing public agencies to take advantage of the benefits of P3s while protecting the public interest. Effective P3 legislation standardizes the process of negotiation as well as the contractual agreements of P3 projects, thereby reducing the transaction costs of the state's P3 market. Moreover, enabling legislation demonstrates a state's commitment to investing in infrastructure in collaboration with the private sector. Hence, the state can inform the private sector about the predictability of the state's market, mitigating the

perceived political and institutional risk in engaging in P3s with the public agencies (Decorla-Souza et al. 2013b).

Geddes and Wagner (2013) statistically analyzed what factors contribute to states' passing P3 enabling legislation, as well as favorability of this legislation, measured by a favorability index based on survey responses by P3 experts in the United States. These elements included a requirement of legislative approval for each project, and a prohibition against mixing public and private funds to finance a project, among others. They found that demand side factors, such as traffic congestion and political conditions, were significantly associated with whether a state has passed a P3 enabling legislation as well as the favorability of the state's institution to private investment on transportation infrastructure. Their analysis also demonstrated that supply factors, such as fiscal conditions, had little to do with a state's P3 legislations.

The literature briefly summarized above points to a few factors that might affect states' decisions on procurement models to be employed. First, states are likely to turn to private financing for infrastructure investments when they face fiscal constraints (Geddes and Wagner 2013). When discussing exclusively private financing of these projects, this hypothesis appears intuitive, but the potential impact of the fiscal conditions on the use of P3s may be more nuanced. For example, when considering P3s as broadly defined to include those that do not involve private financing, the higher initial capital investment costs (as pointed in the review in the Background section) may actually negatively affect whether P3 models are selected for given projects. It is therefore necessary to account for the different contract types of P3s when empirically evaluating the effect of the fiscal condition variables.

Second, demand for infrastructure is likely to be associated with states that employ the P3 models. In the context of highways, increasing travel demand of an economy may encourage state highway agencies to respond by employing P3s to rapidly achieve expansion of highway capacities (Zhang 2008, Geddes and Wagner 2013). Third, political factors may influence the use of P3s. This line of thought is prevalent in the literature on infrastructure privatization. Bel and Fageda (2007) argued that political ideology had been considered important for decisions to privatize. In the context of P3s, this consideration may also be complex. Various interest groups may have distinct positions on the use of P3 models, depending on the rent that could be sought. For example, a number of P3 projects involve tolling schemes due to their financial arrangements (e.g., project finance, which requires a revenue stream for operational and maintenance expenses, repayment of debt obligations, and private investors' return on their equity investment). There are a number of interest groups that may oppose tolling of "freeways." Political condition is an important consideration when empirically investigating the use of P3s by state agencies.

This review of the literature suggests that, while scholars have debated why U.S. states and local governments should utilize P3s, none of the studies has empirically assessed whether public agencies' engagement with P3s are actually driven by their fiscal constraints. In addition, statistical analysis of the association between P3 enabling legislation at the state level and actual implementation has been limited. This is the gap in the literature that this study intends to bridge.

DATA

Because highway capital financing and investment policies are implemented at the state level in the United States, the state is selected as the unit of analysis. The assessment focuses on the period between 1998 and 2010. The beginning year of 1998 is selected because highway P3 projects in the United States experienced substantial expansion since then. In addition, the Transportation Infrastructure Finance and Innovation Act (TIFIA) also passed in 1998. Data on the 50 U.S. states were used in investigating the influence of state fiscal constraints on the implementation of highway P3 projects. The following variables are adopted for the analysis (Table 1).

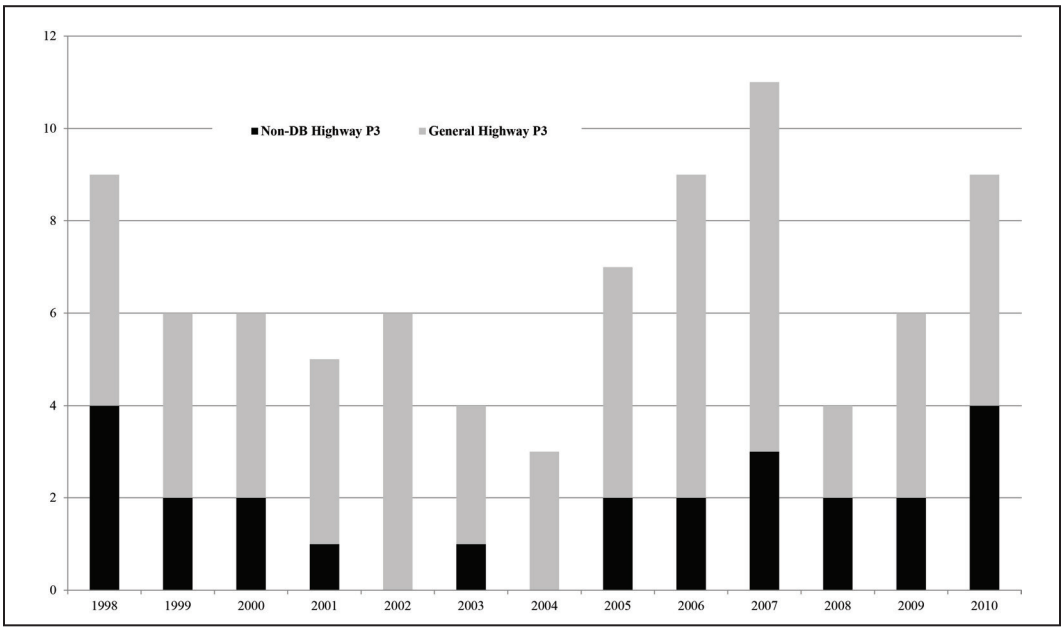
Table 1: Descriptive Statistics

Variables	Mean	Std. Dev.	Min	Max	Unit
Whether state has highway P3 (including DB) (*p3*)	0.09	0.29	0	1	Yes/No
Whether state has highway P3(without DB) (*p3a*)	0.04	0.19	0	1	Yes/No
Lag of state highway net balance (*lagfc*)	60,378	342,891	-1,790,004	3,419,902	Thousands of 2005$
State public debt per capita *(debtpc)*	2,888	1,838	596	10,172	Thousands of 2005$
Highway indebtedness obligation per capita *(laghipc)*	394	337	0.26	2,045	Thousands of 2005$
Lag of state highway capital outlay per capita (*lagcappc*)	232	106	72	757	Thousands of 2005$
Lag of gross state product per capita (*laggsppc*)	39,411	7,526	25,224	65,476	2005$
Growth of vehicle miles traveled per capita (*gvmtpc*)	0	0.08	-0.42	0.92	100%
Dominant party in upper house is Republican (*uh*)	0.49	0.50	0	1	Yes/No
Dominant party in lower house is Republican (*lh*)	0.44	0.50	0	1	Yes/No
Whether governor is Republican (*gov*)	0.52	0.50	0	1	Yes/No
Whether state has P3 enabling law (*p3law*)	0.38	0.49	0	1	Yes/No
Whether state has "cannot carry over deficit law" (*ccod*)	0.74	0.77	0	1	Yes/No

*Total number of observation: 48 (number of states) ×13 (number of years) =624.
Source: Bureau of Economic Analysis, Bureau of U.S. Census and Public Works Financing Newsletter.

- *Public-private partnerships (p3* and *p3a):* Because the financial sources for "design-build" (DB) P3 projects may come from public partners with no private funding source involved, two types of P3 variables are adopted in order to examine whether state fiscal constraints have a different influence on both general P3 projects and non-DB P3 projects. Two dummy variables are created to represent whether a state has P3 projects or not. Both are treated as dependent variables and are analyzed separately. Information on P3 projects such as project location, P3 type, project cost, and date of financial close, is obtained from the P3 project data set produced by Public Works Financing (PWF) Newsletter (2013).[1]
- The dummy variable is coded as "1" if a state in one particular year has one or more P3 projects that are under implementation (including design, planning, or construction), otherwise, a value of zero is coded. Since the scope of assessment only focuses on highway projects, only highway-related P3 projects, including motorway, toll motorway, toll bridge and toll tunnel, are selected for the analysis. Due to the distinct fiscal implications to the states, only the P3s of capacity expansion projects are analyzed, excluding the P3s of other contract types, such as management contracts and brownfield concessions of existing highway capacities. In total, there are 60 highway P3 projects that reached the financial close during the 1998-2010 period,

Figure 2: Highway P3s Including DB and P3 Excluding DB projects in the U.S.



Note: Highway P3s of capacity expansion projects, excluding leases and management contracts.
Source: *Public Works Financing* Newsletter Database.

Figure 3: State Highway Net Balance

State Highway Net Balance (*fc*)	=	**Total Revenue** Federal, state, and local highway user tax revenues Road and crossing tolls Appropriations from general funds Property taxes Other imposts Miscellaneous receipts Bond receipts	–	**Total Disbursement** Capital outlay of state and local roads Maintenance and services of state and local roads Research Law enforcement and safety Interest Bond retirement Grants in aid

Source: Table SF-1, SF-2, Highway Statistics, Federal Highway Administration

which includes 25 non-DB P3 projects.[2] Figure 2 illustrates the variation of both general P3 projects and non-DB P3 projects in the United States.

- *State highway net balance (fc)*: The state highway net balance for the period 1998-2010 is adopted to measure fiscal constraints on state governments in highway financing. It is the difference of total state highway revenue and total disbursements, which is calculated through the equation in Figure 3. According to the FHWA/FTA Final Rule (2007), fiscal constraint is defined as "*a demonstration of sufficient funds (Federal, State, local, and private) to implement proposed transportation system improvements, as well as to operate and maintain the entire system, through the comparison of revenues and costs.*" It is thus reasonable to regard the state highway net balance as the indicator to measure fiscal constraint.[3]

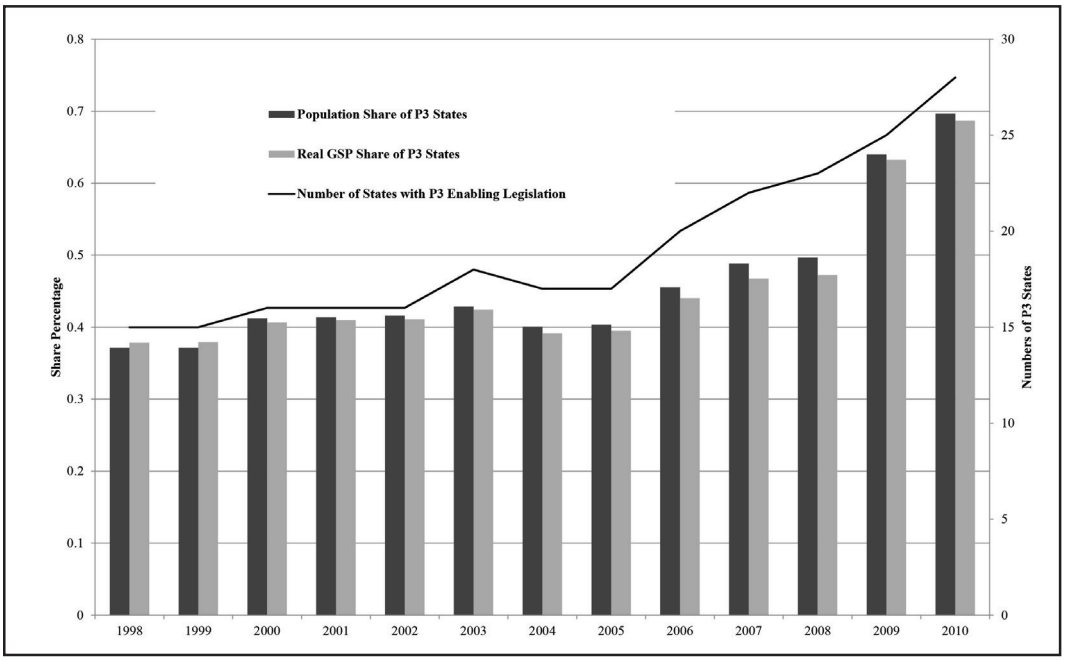
Data on highway capital outlay, revenue, and disbursements are collected from FHWA's annual *Highway Statistics* series (2013). All variables are converted into real monetary terms using World Bank GDP deflator in order to eliminate inflation.

- *State public debt per capita (debtpc):* one of the major arguments for advocating P3 in transportation financing is to reduce the burden of public funds. Since states with higher public debts might be more likely to implement P3 for finance, public debt per capita is introduced to control for the state's financial influence. Data iare collected from the State and Local Government Finance Division at the U.S. Census Bureau.
- *Highway indebtedness obligation per capita (laghipc):* Besides the total public debt of the state discussed above, decision makers could potentially consider P3s for the existing project pipeline driven by the state's debt obligations for highways. Highway indebtedness obligation from the annual *Highway Statistics* for the period 1998-2010 was introduced in the empirical model to control for the financial condition specifically pertaining to its highway capital debt.
- *State highway capital outlay per capita (cappc):* state highway capital outlay per capita is introduced to control for the influence of P3 from the supply side. Theoretically, given the decline of public highway expenditure during the period between 1998 and 2010, as compared with the period of the 1960s to the 1980s, the higher the level of public highway capital outlay per capita, the greater would be the likelihood of its having implemented a P3 project.
- *Gross state product per capita (gsppc):* Data are collected from the regional account of the U.S. Bureau of Economic Analysis (BEA). One year lag of real GSP per capita is adopted to account for the state's economic condition on P3 implementation. The influence of GSP per capita on P3 implementation can run in both directions. On the one hand, the growth in GSP may create more project demand opportunities for collaborations between the public and private sectors and thus may lead to an increase in highway infrastructure using P3s. On the other hand, the opposite linkage may also exist. The decline of an economy may lead to a decrease in public investment, which may consequently provide opportunities for the private sector to be involved in highway projects financing.
- *Growth of vehicle miles traveled per capita (gvmtpc):* This is used to measure variations in highway travel demand through the usage of highway infrastructure. A reasonable assumption is that a higher level of highway user demand requires a higher level of highway capital investment. The data are collected from Table PS-1 of the annual *Highway Statistics* between1998 and 2010, published by FHWA. Per capita level data are used in order to control for the size effect of each state.
- *State legislative composition (uh, lh & gov):* political legislative composition has been found to play a significant role in shaping the decision making about public highway financing policy. For instance, Bruce et al. (2007) found that highway expenditure becomes less if the state has a Republican governor and Republican legislative majorities. To control for these political influences, three political dummy variables are constructed and introduced based on the Composition of State Legislatures, by Political Party Affiliation from the *National Conference of State Legislatures*. *uh* and *lh* are two dummy variables that measure whether the state upper house and the lower house have a Republican majority, respectively. The political affiliation of the governor is also considered. The variable *gov* equals one if the governor is a Republican.
- *Whether state has P3 enabling law (p3law)*: A few studies have found that states with P3 enabling legislation are more likely to implement highway P3 projects (Geddes and Wagner 2013. Rall et al. 2010). The P3 enabling legislation provides guidance for state government to select, develop and execute specific P3 projects. Therefore, the variable is expected to play a role in P3 implementation. One of the features in this assessment is that the P3 enabling legislation variables are coded in a panel data format that includes both regional and temporal information.

We recognize that there are different degrees of favorability of P3 enabling legislation to private investment on transportation infrastructure (Geddes and Wagner 2013). However, investigating the relationships of specific components in the P3 enabling legislations is beyond the scope of this analysis. It is assumed that the inclusion of a dummy variable of P3 enabling legislation would allow us to make a reasonable assessment of the influence of legislative support for the use of P3s.

The number of states with P3 enabling legislation is growing. As illustrated in Figure 4, there were only 15 states with P3 enabling legislation in 1998. During the last decade, the number of states grew to 28 by the end of 2010. This rapid increase of P3 legislation suggests the expansion of potential P3 market across the United States.

Figure 4: Market Share of P3 Enabling Legislation



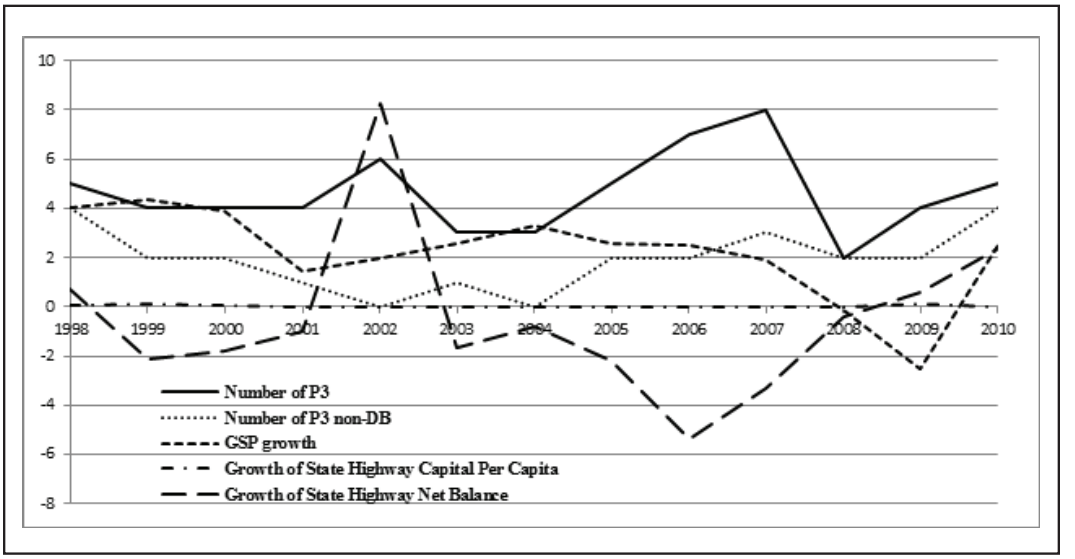
Source: U.S. Bureau of Economic Analysis, and U.S. Department of Transportation

- *Whether state has "cannot carry over deficit" law (ccod):* In the United States, state governments' fiscal constraints are affected by state balanced budget requirements. These legislative requirements can be either constitutional or statutory. Because of the differences in the "cannot carry over deficit" requirement, a government's fiscal constraint varies by state. Whether a state with a "cannot carry over deficit" law is more likely to adopt P3 for highway infrastructure financing is a hypothesis that needs be tested. The information is collected from the State Balanced Budget Provisions, produced by the National Conference of State Legislatures (2010).

The temporal variations of implemented P3 projects, state highway financial status, as well as the state economic output rate are illustrated in Figure 5 The numbers of P3 projects and non-DB P3 projects vary significantly during the period between 1998 and 2010. Gross state product (GSP) growth has a strong lagged influence on the variation of highway P3 projects. After reaching its peak in 2007, the numbers of implemented P3 projects fall significantly following the decline of GSP growth. In addition, the growth of state highway balances also demonstrates a lagged effect on the numbers of P3 projects. While the state highway net balance and the numbers of state highway P3

projects almost move simultaneously in the same direction before 2004, a lagged influence from the state highway net balance becomes more visible during the period after 2004.

Figure 5: Temporal Variation of GSP, State Highway Financial Status and Numbers of Highway P3 Projects



Source: *Public Works Financing* Newsletter Database, Bureau of Economic Analysis and FHWA Highway Administration

METHODOLOGY

The dependent variables *p3* and *p3a* are binary dummy variables. The first denotes whether the state has highway P3 projects, including the DB type. The second denotes whether the state has highway P3 projects, excluding the DB type. The logistic regression model is adopted for this assessment as it measures probabilities of P3 implementation as a function of the explanatory variables. The general model structure can be specified as follows:

$$(1)\quad P(P3\ occurs) = \frac{1}{1 + e^{-(a+b_1X_1+b_2X_2+\cdots+b_kX_k)}}$$

Equation (1) can also be written as:

$$(2)\quad P(P3\ occurs) = \frac{e^{(a+b_1X_1+b_2X_2+\cdots+b_kX_k)}}{1 + e^{(a+b_1X_1+b_2X_2+\cdots+b_kX_k)}}$$

which also equals equation (3) after a log transformation:

$$(3)\quad ln\left(\frac{P(P3\ occurs)}{P(P3\ does\ NOT\ occur)}\right) = a + b_1X_1 + b_2X_2 + \cdots + b_kX_k$$

The left side of Equation 3 indicates the odds that a P3 project is implemented in a state in a particular year, which equals a linear function of a set of explanatory variables *X1, X2, ..., Xk. b* denotes the coefficient that needs to be estimated. The value is interpreted as odds ratios under logistic regression.[4]

Another important issue when assessing the determinants of implementing P3 projects is the lagged effect of explanatory variables. This is particularly true when assessing the influence of a state's fiscal constraints on P3 decision making. The hypothesis is that a state adopts P3s for highway investment when facing a higher level of fiscal constraints than in previous years, which can be indicated by the lag of the state highway net balance.

Public highway capital outlay and economic conditions also have lagged effects on P3 project implementation. A higher level of public highway capital outlay in previous years implies a higher level of public fiscal constraint in funding future highway projects, which may thus encourage the adoption of P3. Likewise, the influence of state economic conditions on highway P3 adoption needs to consider lagged effects, as economic conditions normally do not affect a state government's decision making on highway infrastructure projects immediately because of lengthy negotiations that are common to large and complex P3 deals.

The basic model equations are defined as:

$$(4)\quad p3 = \beta_0 + \beta_1 lagfc + \beta_2 lagdebtpc + \beta_3 laghipc + \beta_4 lagcappc + \beta_5 gvmtpc + \beta_6 lgsppc + \beta_7 p3law + \beta_8 ccod + \beta_9 uh + \beta_{10} lh + \beta_{11} gov + \varepsilon$$

$$(5)\quad p3a = \beta_0 + \beta_1 lagfc + \beta_2 lagdebtpc + \beta_3 laghipc + \beta_4 lagcappc + \beta_5 gvmtpc + \beta_6 lgsppc + \beta_7 p3law + \beta_8 ccod + \beta_9 uh + \beta_{10} lh + \beta_{11} gov + \varepsilon$$

The analysis is implemented in two steps. In the first step, a regular logistic regression is estimated on both models. In the second step, a conditional logit with panel fixed effects model is implemented. The panel fixed effect model is necessary for two reasons, which have been extensively discussed by Allison (2009): first, the dependent variables *p3* and *p3a* are measured on two occasions for each individual state; second, a few independent variables, such as the growth of VMT per capita, GSP per capita, highway capital outlay, and state highway net balance, change substantially over time. A panel fixed effect model can adequately control for the individual fixed effects, which cause such variations.

RESULTS

The two models, the general P3 model and non-DB P3 model, are first estimated using regular logit regression. The explanatory variables are regressed respectively on the general P3 variable and the non-DB P3 variable. Regression results are displayed in Table 2.

In the general P3 model, the coefficient of the lagged state highway net balance variable is not significant, but the state debt per capita is statistically significant at 1% level. The odds ratio is 0.999, which suggests that a one unit increase of the state debt per capita in a previous year is likely to cause an equal chance for the state to have or not have highway P3 projects. In other words, the empirical result suggests that a state's debt level does not affect state government's decision on P3 adoption. The coefficient of the lag of state gross product per capita is found to be significant with an odds ratio at 1, suggesting that the variation of the state's economic output in the previous years has an equal likelihood for a state government to adopt a highway P3 project or not in that particular year, with 5% statistical significance.

In terms of the control variables, the P3 enabling law variable and the governor's political affiliation variable are strongly statistically significant. The odds ratio of the P3 enabling law variable is 3.211, suggesting that if a state has P3 enabling legislation, the odds of having a highway P3 project in that year increases by about 321%. Similarly, the odds ratio of the governor's political affiliation can be interpreted as having a Republican governor increases the odds of having a highway P3 project in that year by about 89%.

Table 2: Results of Regular Logit Regression

	General P3 Model (P3)		Non-DB P3 Model (P3a)	
	Odds Ratios	Z Score	Odds Ratios	Z Score
lag of state highway net balance (*lagfc*)	0.999	-0.99	0.999	-0.55
lag of state debt per capita *(lagdebtpc)*	0.999***	-3.00	0.999*	-1.77
lag of highway indebtedness obligation per capita *(laghipc)*	1.000	1.04	1.002**	2.49
lag of highway capital outlay per capita (*lagcappc*)	1.000	0.04	1.000	0.24
lag GSP per capita (*lagsppc)*	1.000**	1.98	1.000	-0.36
growth rate of VMT per capita (*gvmtpc*)	0.773	-0.10	2.497	0.32
Dominant party in upper house is Republican (*uh*)	0.827	-0.55	0.961	-0.07
Dominant party in lower house is Republican (*lh*)	1.286	0.72	1.202	0.33
Whether governor is Republican (*gov*)	1.887**	2.08	3.663**	2.42
Whether state has P3 enabling law (*p3law*)	3.211***	3.38	2.541*	1.77
Whether state has "cannot carry over deficit law"(*ccod*)	0.927	-0.22	0.635	-0.96
Pseudo R2	0.127		0.145	
No. of Obs.	624		624	

Note: *, **, *** denote significant level at 10, 5 and 1 percent respectively.

The values of odds ratios are found to be similar for the estimates in the non-DB P3 model as compared with the general P3 model. The only difference is that the highway indebtedness obligation per capita is significant while the state gross product variable is not statistically significant. The odds ratio is 1, which indicates the state highway indebtedness has an equal likelihood to influence a state agency's decision on adopting P3 for highway projects or not.

Same as the previous model, the odds ratio of the P3 enabling legislation variable is significant at 2.541. Overall, the model suggests that after controlling for various factors, the variation of state fiscal constraints measured by state highway net balance, highway indebtedness, and state debt per capita, do not affect the odds of implementing highway P3 projects.

The estimation results from the panel fixed logit regression are displayed in Table 3. The "cannot carry over deficit law" variable is not included because it has no within-group variance. The results of the general P3 model show that only the lag of state highway net balance variable and the lag of state debt per capita variable have statistically significant estimates. Both of their odds ratios equal one, suggesting that the variations of fiscal constraints of state highway and state debt level do not affect the variation of the odds of highway P3 project implementation on average.

Table 3: Results of Panel Fixed Logit Regression

	General P3 Model (P3)		Non-DB P3 Model (P3a)	
	Odds Ratios	Z Score	Odds Ratios	Z Score
lag of state highway net balance (*lagfc*)	0.999*	-1.91	0.999	-1.33
lag of state debt per capita *(lagdebtpc)*	0.999*	-1.80	1.002*	1.85
lag of highway indebtedness obligation per capita *(laghipc)*	1.000	0.40	1.005*	1.75
lag of public highway capital outlay per capita (*lagcappc*)	1.002	0.51	1.023***	2.59
lag of log GSP per capita (*lgsppc*)	1.000	0.64	1.000	1.57
growth rate of VMT per capita (*gvmtpc*)	0.300	-0.40	4.920	0.66
Dominant party in upper house is Republican (*uh*)	0.508	-1.04	0.146	-1.36
Dominant party in lower house is Republican (*lh*)	2.226	1.36	11.861**	2.10
Whether governor is Republican (*gov*)	1.521	0.91	1.224	0.24
Whether state has P3 enabling law (*p3law*)	1.786	0.71	0.001	0.00
Year dummy				
1999	0.590	-0.70	0.154	-1.56
2000	0.400	-1.09	0.011***	-2.61
2001	0.408	-0.97	0.002***	-2.87
2002	0.935	-0.07	0.000	-0.01
2003	0.306	-1.10	0.001***	-2.84
2004	0.334	-0.95	0.000	-0.01
2005	0.901	-0.09	0.001***	-2.69
2006	1.510	0.33	0.001***	-2.76
2007	2.485	0.68	0.001***	-2.43
2008	0.306	-0.74	0.001***	-2.63
2009	1.003	0.00	0.001***	-2.64
2010	1.106	0.07	0.001***	-2.27
Pseudo R2	0.110		0.379	
No. of Obs.	312		312	

Note: *, **, *** denote significant level at 10, 5 and 1 percent respectively.

After controlling for individual fixed effects, the odds ratios of lags of highway indebtedness per capita and public highway capital outlay per capita become statistically significant in the non-DB P3 model. Both their values are about equal to one, suggesting that the variation of state highway indebtedness per capita and state's highway capital outlay per capita in a previous year have identical probability, with statistical significance, to influence a state government's decision to adopt or not to adopt P3s for highway projects. The dummy variable of dominant party in lower house is significant with a high value, which suggests that that if the dominant party in a state's upper house is Republican, the odds of having highway P3 projects implemented in a particular year increases substantially.

CONCLUSION

Public private partnerships (P3s) as mechanisms for transportation financing have been increasingly adopted by a number of states in the United States over the last decade. While a few studies have suggested that P3s are implemented to release pressure on public financial resource shortages, the associations between P3 involvement and the state's actual fiscal constraint have rarely been empirically investigated.

This study is conducted to investigate whether states with higher (or stricter) fiscal constraints are more likely to seek P3s for highway infrastructure construction and finance. To test this hypothesis, both the regular logit model and fixed effect logit panel model are adopted. A state's fiscal constraints are measured by the state's net balance, state debt per capita, highway indebtedness, and the "cannot carry over deficit" law dummy. After controlling for factors such as state economic condition, legislative political affiliation, and highway travel demand, our analysis reveals that there was not enough empirical evidence to claim that a state's fiscal constraints affect the implementation of highway P3 projects. These results are in line with with Geddes and Wagner (2013), which found that the fiscal conditions had little to do with states' passing of P3 enabling legislations.

We intend to continue the analysis by focusing on the relationship between the institutional factors and their impact on the P3 market in each state. One potential analysis is to focus on detailed components of enabling legislation and examine how they influence the outcomes of P3 deals. Also, it is possible that by employing alternative approaches to account for the fiscal constraints of the states, different outcomes may arise. It may be necessary to conduct in-depth case studies to document and aid in theorizing how specific elements of P3 enabling legislation affect behavioral dynamics of partners. Policy makers will benefit from these insights to improve their decisions on infrastructure investment.

Endnotes

1. The data set includes projects in all stages of development, from those that are in planning, procurement, or construction now, to completed facilities dating back to 1985. It covers all forms of transportation, water/wastewater, and social infrastructure projects.

2. The year of implementation is defined as the year when a P3 reaches financial close.

3. A further discussion of this approach can be found in Camph (2008).

4. In logistic models, odds ratio measures the ratio of the odds that an event or scenario would happen to the odds of the event or scenario not happening and provides an easier way to interpret influences of explanatory variables on the probability of a certain event or scenario to happen. For instance, assuming an explanatory variable is associated with a 60% chance for the adoption of P3 to finance highway projects in a state, the odds of P3 adoption is 1.5 (0.6/0.4),

whereas the odds of not adopting P3 equals to 0.67 (0.4/0.6). Therefore, the odds ratio for P3 being adopted versus P3 not being adopted is 2.25 (1.5/0.67).

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