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# Socioeconomic impacts of transportation public-private partnerships: A dynamic CGE assessment

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ABSTRACT

While value-for-money and benefit-cost analyses represent traditional approaches for public-private partnership (P3) evaluation, these methods primarily focus on direct, project-level impacts. Indirect regional economic and/or social welfare impacts are generally ignored. This study fills the gap by investigating transportation infrastructure P3's socioeconomic impacts using a dynamic computable general equilibrium (CGE) model. Using the U.S. Commonwealth of Virginia's I-495 Express Lanes project as an example, the model measures infrastructure capital expenditure and tax shock effects and compares them with two public sector comparators (PSCs) representing lower- and upper-bound scenarios. The model also captures the impacts of capital accumulation and temporal variations during the 2008–2012 construction period. The simulation results show that by alleviating the regional economy's collected tax burden, P3s generate greater positive gross economic output and welfare impacts than traditional public financing models.

## 1. Introduction

Public-Private Partnerships (P3s) enjoy a long history in worldwide infrastructure investment (Makovsek et al., 2014) and offer several advantages over traditional financing models. They can add value by incentivizing on-time and on-budget delivery, spur innovation in project design, construction, and life-cycle asset management, and provide access to new capital sources (Casady and Geddes, 2016). Given the challenges facing conventional infrastructure funding mechanisms in recent years, P3s have received increased attention within the U.S. The federal government, for instance, has enacted innovative financing arrangements—including private activity bonds (PABs) and Transportation Infrastructure Financing and Innovation Act (TIFIA) loans—to encourage private investments in qualified infrastructure projects. Furthermore, 34 U.S. states, the District of Columbia and Puerto Rico have enacted legislation enabling public agencies to employ P3 contracts for transportation infrastructure development.[1] As a result, more than 40 existing and anticipated U.S. P3 transportation infrastructure projects currently involve private financing (Federal Highway Administration (FHWA), 2016).

Our understanding of P3s is informed by contract theory, as developed by Williamson (1979) and Hart (2003). Contract theory postulates that P3 structures incentivize private investment in innovative technologies to save project costs and/or improve service qualities that are not explicitly contracted (Hart, 2003). Supported by Williamson (1979), Hart (1995) developed a theoretical framework viewing infrastructure P3s from the perspective of incomplete contracts for services that were characterized with an asset specificity. Under the P3 arrangement, ownership, private equity investments, and private financing encourage private contractors to maximize revenue through service quality improvements and cost reductions (Bennett and Iossa, 2006; Martimort and Pouyet, 2008; and De Bettignies and Ross, 2009). A recent proposition by Iossa and Martimort (2015) provides a comprehensive framework with which to consider P3 contracts' welfare implications. They argue that P3s are particularly desirable when: 1) improved facility quality reduces life-cycle delivery costs; 2) service demand and maintenance costs are sensitive to facility quality; and 3) demand is stable and easy to forecast. Overall, the contract's incentive effect on innovative technology investment is a critical component for theoretical P3 considerations.

Based on this framework, evaluations of alternative procurement models focus on whether expected lifecycle cost savings justify additional P3 contract costs (Välilä, 2005). As a result, public agencies often employ Value for Money (VfM) and/or benefit-cost analyses to evaluate whether P3 procurement offers greater feasibility and efficiency compared to traditional public procurement. These traditional P3

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evaluation methods focus on P3s' direct, project-level impacts, typically ignoring indirect regional economic and social welfare impacts. VfM analysis, for example, assesses a project's financial aspects with respect to alternative procurement approaches but fails to account for non-financial economic benefits and costs. In particular, this approach cannot account for time disparities between traditional public procurement and accelerated P3 delivery enabled by private financing (DeCorla-Souza et al., 2016). The approach is also subject to issues with discount rate selection and tax position adjustments (Yescombe, 2007; Chen et al., 2016). Furthermore, traditional evaluation methods have difficulty accounting for an infrastructure project's economic burden distribution based on its financial arrangements (e.g., tax-based funding, user-fee based financing, etc.). Without capturing such arrangements, P3 assessments can generate significant inaccuracies.

To address these limitations, the present study improves P3 evaluation by measuring transportation infrastructure P3s' indirect regional economic and social welfare impacts. Using the U.S. Commonwealth of Virginia's I-495 Express Lanes project as an example, the study aims to address two research questions. First, what socioeconomic impacts develop from transportation infrastructure when evaluations account for financing and procurement decisions? Second, how do these impacts vary between P3 and non-P3 financing and procurement schemes?

The present study offers an exploratory example limited to a highway project's construction phase and provides two important insights for procurement model evaluation frameworks. First, the empirical case evaluation demonstrates P3s' indirect benefits compared to traditional procurement approaches, potentially informing future policy debates regarding increasing private-sector roles in infrastructure investment. Second, the CGE modeling framework developed in this study provides new insights for incorporating regional economic and social welfare impacts into transportation agencies' existing P3 evaluation tools. This, in turn, promises to provide more accurate P3 outcome assessments to facilitate future P3 practice and decision-making.

The paper continues with research background discussed in Section 2. Section 3 then presents the research methodology, followed by a discussion of data in Section 4. Section 5 interprets the results while and Section 6 discusses policy insights and directions for future analysis.

## 2. Background

Infrastructure project delivery involves multiple phases: planning, design, construction, operation, maintenance, renewal or termination, etc. As facility owners, governments must determine which phases to undertake using in-house resources and which to complete using hired contractors. If contracting out, the owner must also decide whether to bundle project multiple phases into a single contract (e.g., design and construction phases) or separate the phases across multiple contracts. Incomplete contract theory describes such bundling choices. At one extreme, public delivery, driven by social welfare maximization, employs no private contracts. This approach depends exclusively on public agency resources (e.g., in-house staff, tax revenues) and allocates all project design, construction, and operating risks to the public sector. At the other extreme, privatization (or divesture) shifts all project phases and associated risks to a profit-maximizing private sector. Public-private partnerships encompass the diverse contract types falling between these two extremes.

More specifically, the Organization for Economic Cooperation and Development's (OECD's) International Transport Forum (ITF) defines a P3 as "an agreement between the government and one or more private partners (which may include the operators and the financiers) according to which the private partners deliver the service in such a manner that the service delivery objectives of the government are aligned with the profit objectives of the private partners and where the effectiveness of the alignment depends on a sufficient transfer of risk to the private partners" (ITF and OECD, 2008). The U.S. Federal Highway Administration (FHWA), in turn, defines P3s as "contractual agreements formed between a public agency and a private sector entity that allow for greater private sector participation in the delivery and financing of transportation projects" (FHWA, 2016).

In this sense, contracts deviating from traditional procurement models in ways that transfer project risks to private firms may be considered as P3s. As a result, the present analysis investigates differences between the public sector's conventional design-bid-build (DBB) model and delivery models where private-sector contracts procure project delivery stages separately. Table 1 lists the most common such P3 contract types employed for infrastructure financing and procurement (Hodge et al., 2010). This present study will focus on projects delivered through DBFOM agreements that bundle design, construction, financing, operation and maintenance phases into single contracts.

Note that the P3 contract types outlined in Table 1 do not specify funding or financing sources (e.g., project finance; availability payments, etc.). Each project's unique funding sources, financing options, environmental conditions, and risk profile will influence its financial arrangements. P3s can employ user-fee arrangements in the absence of other funding or financing options, but they do not automatically equate with toll roads or similar measures. Conversely, not all toll facilities involve P3 contracts.

P3 contracts offer a complex network of potential benefits and costs (Grout, 1997; Hart, 2003; Hodge, 2004; Hodge et al., 2010). For example, the conventional DBB model can support accountability and transparency but may not provide sufficient cost efficiencies to accommodate tightening government budgets. P3 contracts, in contrast, incentivize profit-driven contractors to adopt new technologies or practices to minimize life-cycle costs of infrastructure projects. Similarly, discrepancies between design specifications and actual site conditions can easily develop into expensive cost and schedule overruns. While public agencies bear this considerable and possibly systematic risk under the DBB model (Flyvbjerg, 2009, 2014), P3 approaches can delegate authorities, responsibilities, and risks to the private sector. Such arrangements require extremely complex contractual arrangements, however, introducing significant transaction costs (e.g., legal, financial, engineering, and consulting). Given such efficiency tradeoffs, risk transfers, and transaction costs, governments and

**Table 1**
Selected P3 contract types.

| Type | Description | Infrastructure Project Examples in the U.S. |
|---|---|---|
| DBFO | Design, build, finance, and operate | Santa Rosa Prison (NM) |
| DBFM | Design, build, finance, and maintain | Goethals Bridge (NY) |
| DBOM | Design, build, operate, and maintain | Route 3 North (MA) |
| DBFOM | Design, build, finance, operate, & maintain | North Tarrant Express (TX) |
| BLT | Build, lease, and transfer | Patent/Trademark Building (VA) |
| BOL | Build, operate, and lease | – |
| BOO | Build, own, and operate | San Francisco Giants Stadium (CA) |
| BOOR | Build, own, operate, and remove | – |
| BOOT | Build, own, operate, and transfer | – |
| BOT | Build, operate, and transfer | Cauley Creek Water Reclamation (GA) |
| LROT | Lease, renovate, operate, and transfer | – |
| ROT | Rehabilitate, operate, and transfer | – |

Sources: Hodge et al. (2010); Public Works Financing Project Database.