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Social welfare analysis of investment public–private partnership approaches for transportation projects

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ABSTRACT

This paper has two objectives: (i) to introduce a new approach in order to gain widespread support for road pricing; and (ii) to develop a detailed social welfare analysis for road pricing schemes. We first describe our novel approach that stimulates public support for road pricing, which we refer to as an investment public–private partnership, or IP3. This approach returns a significant portion of the economic value created by road pricing back to the citizens who own the newly priced facility. We then present a social welfare framework that estimates the benefits and costs of using the IP3 approach on an urban transportation network. A P3 project's impact on overall social welfare provides a more comprehensive evaluation criterion than the often-used Value for Money (VfM) analysis. Apart from several theoretical studies, a detailed social welfare analysis that includes all major P3 project stakeholders is absent from the literature. We use Fresno, California as our case study in order to conduct a welfare analysis on IP3s. Our results show that system-optimal tolling favors average users, but that government—and consequently taxpayers—should pay for costly tolling systems (negative profits). In contrast, unlimited profit-maximizing tolls raise substantial profits for government, for the infrastructure's citizen-owners, and for the private sector, but the average user is worse off. From a social-welfare perspective, one should search for a Pareto improvement under which all major stakeholders are better off. Our estimates indicate that a mixed public and private tolling scheme offers such an improvement.

1. Introduction

The question of which type of transportation facilities, business models, and ownership structures underpin successful public–private partnerships (P3s) is becoming more relevant for both public- and private-sector infrastructure stakeholders. Answers may lie in exploration of new and innovative policy approaches that capture the potential of P3s to address endemic infrastructure funding, project delivery, and service quality challenges (Rouhani, 2012).

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In response to such growing concerns, Geddes and Nentchev (2013, 2014) suggest a new approach, called an investment public–private partnership, or IP3. The IP3 offers a strategy that could increase public support for system-wide pricing of existing roads. The approach does so by releasing economic value embedded in transportation facilities that cannot be realized since road use is not priced. The approach explicitly recognizes the right of the citizens who own public infrastructure to receive income generated from it. Such rights are rarely, if ever, recognized. By encouraging road pricing, the IP3 approach also facilitates additional investment in transportation infrastructure. We describe the IP3 approach in detail in Section 2.

The first step to evaluate an IP3 (and in general, any project) is to determine the appropriate criterion in order to measure the project's potential benefits and costs. The relevant criterion determines whether or not the approach serves the overall public interest. Government agencies often evaluate P3 projects using Value for Money (VfM) analysis (Yuan et al., 2009), but the most appropriate evaluation criterion is overall social welfare (Boardman and Vining, 2012). In fact, VfM analysis might lead to the implementation of projects that reduce social value since it accounts only for the costs of project development; the benefits to users or consumers are excluded (Heald, 2003; Boardman and Vining, 2010).

VfM studies also often use inappropriately high discount rates (Johnston, 2010). To provide a detailed social welfare analysis, major stakeholders' gains and losses from using a P3 should be compared to the gains and losses from a traditional (i.e., public-procurement only) approach to providing the same infrastructure or service.

Theoretical modeling of social welfare associated with private operation of priced roadways has examined the effects of duopoly and monopoly structures (Zhang, 2008; Winston and Yan, 2011; Rouhani et al., 2013a), the effects of traffic diversion to secondary roads (Swan and Belzer, 2010), and the impact of alternative privatization structures and regulations (Yang and Meng, 2000; Tan et al., 2010; Zhang and Yusufzyanova, 2012). Such studies have focused mainly on system travel time on a few selected roads only. None have developed a detailed analysis including various welfare components in P3 implementation.

In the congestion pricing context, Parry and Bento (2002) analyzed social welfare interactions between direct peak-period congestion pricing and "second best" factors, including congestion on un-priced routes, as well as accident and pollution externalities. Safirova et al. (2004) examined the welfare effects of various road pricing schemes for the Washington, DC, metropolitan area. Major factors in those analyses were changes in travel time and tolls paid. Social welfare studies generally impose strong assumptions regarding implementation of the same toll rates on all roads, application of a macro model (with limited details about system components), and exclusion of externalities other than travel-time-based congestion. In contrast, we show that the key impacts of the IP3 approach can be captured within the boundaries of urban cities. Our approach estimates important and complex interrelations between different components of an urban transportation system and between different stakeholders within the IP3 approach.

A detailed social welfare analysis that includes all major P3 project stakeholders (residents, users, government, and the private sector) is absent from the literature. To fill this gap, we focus on developing a general framework for social welfare analysis that includes major stakeholders within an IP3 approach. We next describe the modeling required for evaluating an IP3 scheme in an urban transportation context, and estimate the social welfare change from implementing IP3 alternatives for a major urban city: Fresno, California. Although our focus is on the IP3 approach, our modeling framework can be generalized to other P3 models, such as Greenfield projects, and to similar tolling (i.e., road pricing) schemes.

2. The investment public–private partnership

There is widespread agreement among transportation economists that many problems associated with the delivery, operation, and maintenance of transportation infrastructure could be addressed through the adoption of system-wide road pricing (Vickrey, 1992), e.g., charging motorists a variable per mile fee for road use (Velaga and Pangbourne, 2014). Such fees are often referred to as mileage-based user fees or MBUFs (Burris et al., 2013). Researchers have however recognized that this represents a major policy change, and that motorists are likely to resist road pricing.

There is a growing multi-disciplinary literature on strategies for enhancing public acceptance of road pricing. Small (1983, 1992) and Anderson and Mohring (1996) stress that added revenue from road pricing must be used prudently in order to gain public acceptance. Small (1992) suggests using a portion of new revenues for tax reductions and rebates in the relevant region and the remainder for regional transportation improvements. King et al. (2007a) argue for allocating revenues to the jurisdictions (e.g., cities and towns) through which newly priced freeways extend. Kockelman and Kalmanje (2005) analyze what they call credit-based congestion pricing. They suggest rebating toll credits (equal to average monthly usage) back to motorists. Arnold et al. (2012) suggest enhancing public acceptance by increasing motorists' travel choices. They recommend converting the shoulder of a highway into a new general purpose lane while converting the left lane into a high-occupancy toll (HOT) lane. Other suggested approaches include toll revenue "recycling" in which toll revenues are rebated back to motorists (Parry and Bento, 2001).

Although innovative, the above proposals generally ignore the role of the citizens who actually own the infrastructure. A basic tenet of property law is that asset owners possess the right of *fructus*, which is the right to retain the fruit, produce, or to profit from an asset (Garner and Black, 2009). U.S. transportation infrastructure assets are almost completely