



# Modeling the effect of contractual incentives on road safety performance



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## ABSTRACT

New contracting approaches, such as Public Private Partnerships (PPPs) are becoming quite popular all around the world to improve the delivery of infrastructure in order to provide value for money. However, the goals of the Government and the private sector may conflict with each other. Whereas the government's goal should be to maximize social welfare through increasing value for money, the private sector is focused on maximizing its profit. Introducing performance based incentives—bonuses and penalties—tied to social goals in contracts is a popular way to align private and government objectives to achieve value for money. The goal of this paper is, by using a quantitative model, to evaluate whether toll highway PPPs, especially those incorporating safety performance based incentives, are actually safer than conventionally procured roads. To this end we have calibrated negative binomial regression models using information from the Spanish high-capacity road network covering years 2007–2009. The results show that toll highways, especially those with safety performance incentives, are *ceteris paribus* safer than conventionally procured roads, even though safety is still influenced by variables not manageable by the contractor such as traffic volume.

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## 1. Introduction

Public Private Partnerships (PPPs) are mostly implemented to circumvent budgetary constraints, and encourage efficiency in the provision of public infrastructure in order to improve social welfare through value for money (VFM) gains, and better quality of service. PPPs will be successful insofar as VFM is achieved, or services are improved for the same amount of money as the public sector would have spent to deliver a similar project (Grimsey and Lewis, 2005; Morillos et al., 2009).

The concession contract approach has been the legal framework used for dealing with PPPs in many civil law countries. Concession contracts are long term contracts between a concessionaire and the government whereby the concessionaire has the obligation to build and manage a public infrastructure facility on behalf of the public sector (Vassallo and Gallego, 2005; Grimsey and Lewis, 2000).

Concession contracts should include the necessary provisions in order that the relationship between the public and the private sector work at their best throughout the life of the contract. Therefore, the bidding terms and contracts should comply with

two requirements: first, ensure that the most efficient bidder, in terms of price and quality, is awarded the contract; and second, provide incentives to the contractor to render the highest quality level compatible with a reasonable cost.

One of the ways of reaching VFM in PPP projects is by introducing performance based incentives tied to bonuses and penalties to reward or punish the performance of the contractor. The incentives given to the contractors should meet social goals measured through performance indicators. The overall goal when setting up payment mechanisms based on performance-based standards is to align public benefits and private profits (Rangel and Galende, 2010; Harding et al., 2010). For road infrastructure these performance-based standards often refer to different aspects such as availability, congestion, state of the pavement and safety issues (Rangel, 2011; Abdel Aziz, 2007).

In this paper we focus on the safety performance of road PPPs, especially those with safety incentives. We chose road safety because it is one of the most important criteria for social welfare. Traffic accidents often result in huge economic and social costs. The aim of this paper is twofold: first, to evaluate whether PPPs lead to road safety improvement when compared to other road management approaches; and second, to analyze whether performance-based incentives in PPP contracts have been actually effective in improving safety performance. To that end, we develop a methodology to analyze the effect of safety incentives on accidents in highway PPPs.

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We apply this methodology to the case of Spain because in this country there are different road management approaches for highways with similar design characteristics. This will enable us to compare several management approaches by using statistical modeling. There are two main types of high capacity roads in Spain: toll highways PPPs, which are built and managed by private companies; and free highways (*autovías* in Spanish), which are built and managed by the government through conventional procurement approaches. *Autovías* can be split in their turn into first generation *autovías*, with worse alignment characteristics, and second generation *autovías*, with alignment characteristics akin to toll highways. Toll highways (PPPs) are contracts where a private company manages the whole life-cycle of the road: design, construction, maintenance and operation. Some of the toll highways (PPPs) in Spain incorporate economic incentives to reward the PPP contractor if road safety improves. *Autovías* are operated by the public sector through conventional contracts without any sort of economic incentives.

Apart from the introduction, the paper contains four additional sections. In Section 2, right after the introduction, we describe the practical experience in the introduction of performance-based incentives in highway PPPs. In Section 3, we show a review of the models explaining the variables influencing road safety ratios. In Section 4 we explain the data and the methodology used for the empirical analysis. In Section 5 we show the results. In the 6th and last section, we highlight the main conclusions and the implications for the public authority.

## 2. Performance-based incentives in PPPs to improve safety

### 2.1. Concept

Performance-based incentives have been used as a common compensation for PPP road projects. In the past few years, PPP contracts have included incentives to encourage bidders to reach the optimal level of service, in such a way that any increase in efficiency will be transferred to the users by setting up indicators linked to bonuses and penalties (Vassallo, 2007; Rangel, 2011). This mechanism is generally based on fixing a number of minimum standards to be fulfilled by the contractor. If the contractor fails to comply with these requirements, the public authority will penalize the contractor or even rescind the contract; and, if the contractor performs above these requirements, he will be rewarded.

The main reason of incentivizing the contractor is to achieve social objectives. PPPs can provide higher value for money compared to other infrastructure management approaches insofar as the objectives of all parties are met within the contract (Benito et al., 2008). As mentioned before, the incentives given to the contractors should reflect and meet social objectives set up by the government.

The main objective for the government is to maximize social welfare through increasing VFM. However the private sector objective is to maximize its profits. These different goals may conflict with each other. One way of aligning the goals of the private sector and the government in order to increase VFM is to introduce incentives tied to bonuses and penalties in PPP contracts (Vassallo, 2007; Rangel, 2011).

A common approach to specifying the quality of service outputs is to develop a matrix of key performance indicators (KPIs) which set the requirements for each service output. KPIs are widely used to manage performance in PPP contracts.

The tender process when incentives tied to performance-based standards are included is based on the “best value”. It involves choosing a contractor who, having agreed to comply with the

requirements of KPI established in the contract, submits the lowest tender in terms of price. The “best value” approach tries to ensure the highest quality at the lowest cost (Crispino et al., 2008).

Some of the most common standards introduced in road PPP contracts are: congestion (average travel times), accidents (number of traffic incidents), comfort (pavement surface conditions), impact on the environment (number of incidents of breach in noise/air quality requirements), provision of information for highway users (accuracy and frequency) and vehicle breakdown (services/availability and response time).

### 2.2. International experience with safety-based incentives

There are some countries in Europe that introduce safety-based incentives based on explicit road safety indicators in PPP roads. This happens in Spain, Finland, Hungary, Norway, Portugal, Slovakia and United Kingdom. The design of road safety indicators is quite heterogeneous across different countries. There are differences both in the variable adopted to measure the outcome and in the final formula employed. Most of the PPPs include the number of accidents, injuries and fatalities to build the indicator. Besides, including the exposure to the risk (expressed by traffic) to build the indicator is a generalized practice: E-18 road (Muurla–Lohja) in Finland, M6 road in Hungary, several PPPs in Portugal (the IP-4, for instance) and the latest PPP roads awarded in Spain use this methodology. The advantage of introducing the exposure to the risk (traffic) explicitly is that distortions in road safety results are reduced.

With the same aim, in many other PPP contracts the assessment of the indicator is done by comparing similar roads, in terms of traffic, number of carriageways, etc.: E-18 road (Grimstad–Kristiansand) in Norway, the latest PPP roads awarded in the United Kingdom (A1 and M25) and some PPP roads in Spain (like the M-407 highway).

Regarding the way of rewarding or penalizing the contractor, we have identified two trends: incentives related to the extension of the deadline of the project, and incentives related to the increase of the fee to be paid to the PPP contractor.

### 2.3. The case of Spain

Spain has extensive experience in managing and financing highways through PPPs. Most of the PPPs have been put into effect through concession contracts that have a long tradition in Spanish administrative law. The first highway concessions awarded in Spain have been toll highways (Izquierdo and Vassallo, 2004).

In the last few years, Spain began introducing performance based incentives in toll highways. Toll highway concession contracts include a provision to extend the contract duration up to four years if the PPP contractor performs above the minimum quality standards tied to congestion, state of the pavement, safety, and satisfaction of the users. Regarding safety, the PPP contractor can be granted an extension of the contract if safety indicators remain below an accident benchmark for similar roads. To that propose the government measures in a yearly basis the Risk Index (RI) of the highways and compare it with other highways with similar characteristics in terms of alignment and traffic flow.<sup>2</sup>

<sup>2</sup> The concessionaire will be entitled to one additional year of the concession contract if, at least, 90% of time during the 35 years of the concession, both RI and MI remain between 90% and 75% of the annual average value of those toll highway concessions with similar Annual Average Daily Traffic (AADT) ( $\pm 5000$  vehicles/day). Besides, the concessionaire will be entitled to two additional years of the concession contract if, at least, 90% of time during the 35 years of the concession, both RI and MI remain below 75% of the annual average value of those toll highways with similar Annual Average Daily Traffic (AADT) ( $\pm 5000$  vehicles/day).

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