Do Public-Private Partnerships promote road safety?

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Public Private Partnership (PPP) has become a common way of providing high-quality roads in many countries worldwide. One of the main reasons of PPP implementation has been to improve efficiency and quality in the service, although the effects of PPP management on road safety have not yet been analyzed. Taking the advantages of the particular mixed managing model the Spanish highway network offers and applying Propensity Score Matching method we estimate the impact of the PPP on road safety. Results show that control traffic stations placed on motorways that are privately managed record about 17% – 42% less number of accidents involving victims per km, 23% – 47% less number of injures per km and 17% – 94% less number of death per km.

KEYWORDS: Public Private Partnership, motorways, road safety, Propensity Score Matching.

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1. INTRODUCTION

One of the most important objectives for transport authorities around the world is road safety improvement. According to World Health Organization (2013), approximately 1.24 million people die every year on the roads, and another 20 to 50 million sustain nonfatal injuries as a result of road traffic crashes. In 2012, in the European Union[1] alone, the total number of fatalities from road accidents were 15,303 (data for 15 out of the 28 EU Member States), 3 from airplane accidents (fatalities from accidents on national territory regardless of the nationality of the aircraft operator), and 1,133 from railway accidents. Although road traffic accidents in the European Union have been declining in recent years (European Union, 2012), road transport remains the most dangerous mode of transport.

The economic costs associated with road accidents are high in terms of health spending and productivity losses in both developed and developing countries. Therefore, reducing the number of traffic accidents is fundamental to reduce the total economic costs associated with these tragedies. Research for the 2009 (European Commission, 2010) estimates the total economic costs from road accidents in 130 billion Euros, corresponding to approximately 2% of the GDP.

In many developed and developing countries Public Private Partnership (PPP) has become an important and desirable way of providing services traditionally procured by the public sector. This PPP involves a contract between public administration and private companies in which private party is engaged to finance, build and manage a project trough a long-term contractual agreement until the contract expires and the asset returns to public ownership (Grimsey and Lewis, 2004; Blondal, 2005; Yescombe, 2007). Large parts of highway networks in Europe, South America and more recently in the United Sates have been built or rehabilitated through PPP contracts (Albalate, 2014; Engel et al, 2003; Bel and Foote, 2009). One of the main reasons for PPP implementation has been to improve efficiency and quality in the provision of services, although the effects of PPP on road safety have not yet been analyzed.

The particular mixed managing model of the Spanish highway networks gives an extraordinary opportunity to determine whether PPP management offer more service quality than traditional procurement. The highway network management in Spain is quite singular compared to most European countries. Today 23.5% of the total network is managed by

[1] Eurostat database

private companies (PPP) and a 76.5% is managed by the public sector, but to better understand the mixed model, we must go back to the early 60's.

Having overcome the hardest years of the autarky, the Spanish economy was growing fast but transportation infrastructures were insufficient for productive activities. An expanded and modern highway network was required at a time when the public budget was insufficient to afford such investment; therefore the government opted for private funding to reach that goal. At the end of the 60´s the first motorway concession was awarded to the private party and as early as 1975, more than 1,800km of private motorways was already constructed. However the democratic transition and the oil crisis increased the financial expenses and construction costs that bring the highway network expansion work to a halt.

In the early 80's, the discouraging experience of the first stages caused a drastic change in the financial model. The new government that took into an office in 1982 established a new plan for modernizing the Spanish highways network exclusively financed by public funds. The plan involved the building of public motorways and widening and upgrading the most important roads, turning them into dual-roadway fast lanes. This plan brought the consolidation of the mixed management model for the Spanish highway network (Bel and Fageda 2005; Albalate et al; 2009, Albalate, 2014).

In the early 90´s, the length of the Spanish highway network was around 5,800km, of which 1,900km was privately managed and 3,900km managed by the state but, in the mid 90´s the government approved a new ambitious plan. The main objective of the new plan was that by the 2007 the Spanish highway network should be more than 11,000Km. In 1997, the government changed again, and the interest in the private financing of motorways was renewed. However, the government continued with its efforts to extend the public motorways. Between 1996 and 2003, the government added around 3,800km of high capacity roads, more than 3,300km of which were public funded.

In 2005, the government approved another infrastructure plan. In this plan, the main objective was to modernize the first generation of public motorways that had been constructed at the end of the 80´s. In 2007, the government awarded to the private sector 900km of the first generation of public motorways to be remodeled. From 2004 to 2014 around 3,700km of high capacity roads have been added to the highway network, of which 400km are privately managed and 3,200km managed by the state.

The aim of this study is to evaluate whether PPP management offer better quality in terms of road safety than traditional procurement. To perform the analysis we take the advantages of the particular mixed managing model of the Spanish highway network offers. Using three repeated cross-sectional databases for 2008, 2009 and 2010 and applying propensity score matching method we estimate the impact of the PPP management on road safety. As the PPPs were not randomly applied, the propensity score matching method is considered a robust way to reduce selection bias from motorways that received the treatment and from those that did not. The number of accidents involving victims per km, injures and death are used as proxies for the motorway quality.

The rest of the article is organized as follows. Section 2 reviews studies on quality privatization. Section 3 describes the empirical strategy and the data. Results are presented in section 4. Finally, in section 5 we present our main conclusions and policy implications.

2. LITERATURE REVIEW

Since the early eighties, the implementation of the privatization to deliver certain facilities and services traditionally procured by the government has become a common practice. However, economic theory is ambiguous about whether quality would be better with privatization. The property rights theory of ownership (Hart et al, 1997) shows that public provision is better than privatization when non-contractible cost reductions have dangerous effects on quality and when quality innovations are unimportant. In contrast, privatization is stronger when quality reduction by costs reduction can be controlled by contract or competition and when quality innovations are important. Supporters of privatization claims out private sector can delivers public services more efficiently than governments, but critics believe that private companies will prioritize economic revenues over quality of services (Prizzia, 2001).

The majority of the empirical literature analyzing the effect of privatization is in terms of costs (Jensen and Stonecash, 2005) and in terms of costs and quality (Andersson and Jordahl, 2011) but the strict relationship between ownership and quality has not been a major topic in the literature yet (Boyne 1998; Brown and Potoski, 2003), particularly in transportation literature. However, we can collect some useful results from water and hospital provision that traded similar concerns regarding quality and management in which health outcomes have been used as a way to measure the quality of the service.

First we can mention the seminal work of Galiani et al (2005) that tray to evaluate the impact of the privatization of water services on the mortality of children. They compare child mortality under age 5 when water services are privately provided to the counterfactual child mortality when services are publicly provided in Argentina. Results show that child mortality fell by approximately 8% in the areas in which water systems were privatized.

Inspired by the seminal work of Galiani et al (2005), Nassima (2012) evaluates the effect of the water partial privatization on the children's diarrhea in Senegal. Results show that the number of children´s water-related diseases has fallen after the PPP. In the same lines, Kosec (2013) test whether water private sector participation affects the prevalence of diarrhea in urban children under age 5 from 39 African countries during 1986-2010. Results suggest that private sector participation in the water sector substantially improves the health of young children by reducing the prevalence of diarrhea.

In the empirical studies of hospital provision some interesting results can be found. Shortell and Hughes (1988) examined the effects of hospital ownership on mortality rates in United States. Authors found no statistically significant association between mortality rates among patients and either the type of hospital ownership. In the same lines of study, Hartz et al. (1989) found that mortality rates in American hospitals were significantly higher for for-profit hospitals and public hospitals than for private not-for-profit hospitals. Keeler et al (1992) compare quality of elderly care in hospital ownership on five diseases in United States. Results suggest that public hospitals offers lower quality than private hospitals.

Other studies more related on road safety and management could be found in the re-routing transportation literature. Re-routing literature supports that road accidents are higher in the alternative free roads (usually managed by the public administration) than in the adjacent charged roads (usually managed by private sector) due to charging encourage divers to use a minor alternative free road.

From this group of studies we can mention first the work of Broughton and Gower (1998). The authors analyzed the effects of motorway tolls on the number of accidents in United Kingdom. Results show that a 10% diversion of motorway traffic from the motorways in Kent would increase the number of accidents in the entire county by about 3.5 %. In similar lines, Albalate (2011) tests whether charging for the use of better roads might negatively affect road safety on the adjacent roads. The author found that road accidents in Spain are higher in routes adjacent to toll motorways than those adjacent to free motorways. By the other hand, Albalate and Bel (2012) investigates the relationship between different types of road quality and their impact on national safety outcomes using European panel data. Results shows that motorways are the only type of road associated with reduction in traffic fatalities, consequence of re-routing effect.

The present study takes advantage of these results in order to attempt a different concern, which is whether private management offers better quality than traditional procurement in the motorway sector. In the next section we describe the data used and the empirical strategy proposed.

3. EMPIRICAL STRATEGY AND DATA

Our empirical strategy relies on estimating the average effect of the Public Private Partnership on the number of motorway fatalities in the Spanish roads in order to test whether private management has some effects to improve road quality. To test our main hypothesis we take advantage of the particular mix model of management given in Spanish motorway network. The methodology applied to estimate the effects is propensity score matching (PSM). After describing in this section the method, we proceed to explain the main data and variables employed.

3.1. Methodology

Propensity score matching (PSM) is an alternative method to estimate the effects of receiving treatment when random assignment of treatments to subjects is not feasible. Since the concept of PSM was first introduced by Rosenbaum and Rubin (1983), the method has been widely used in medical trials (Xu, Z. and Kalbfleisch J.D., 2010) and in the evaluation of policy intervention such as labor market training programs (Heckman et al., 1997; Dehejia and Wahba, 1999).

The basic idea behind PSM is to find in a control group those observations that are similar to the treated group in all relevant pre treatment characteristics. Since matching observations on a large vector of pre treatment characteristics is not feasible, this method proposes to summarize pre treatment characteristics of each observation into a single variable, the propensity score. The propensity score[2] is the conditional predicted probability of receiving treatment given pre treatment characteristics. Formally, the propensity score can be written as follow:

$$p(x) \equiv Pr(D=1/x)=E(D/x) \qquad (1)$$

where D is a binary variable that determines if the observation has the treatment (D=1) or not (D=0) and x is the multidimensional vector of pre treatment characteristics.

The parameter of interest is the difference between the outcomes of treated and the outcomes of the treated observations as if they had not been treated, the average treatment effect on the treated (ATET)[3], which is defined as follow:

$$ATET= E\ (y1\text{-}y0/\ D=1)=E\ (y1/\ D=1)\text{-}E\ (y0/D=1) \qquad (2)$$

The second term is a contrafactual, it is no observable and needs to be estimated but two crucial assumptions are required, the Conditional Independence Assumption (Unconfoundedness Condition) and the Overlap Assumption (Common Support Condition).

The Conditional Independence Assumption (CIA) states that the outcomes are independent of treatment conditional on pre treatment characteristics. This assumption is crucial to obtain consistent causal estimates of treatment effects. The CIA based on the propensity score can be described as follow:

$$(y0,\ y1) \perp D/p(x) \qquad (a)$$

The Overlap Assumption (OA) ensures that for each value of pre treatment characteristic, there are both treated and control observations and for each treated observation, there is a matched control observation with similar pre treatment characteristics. The OA can be described as follow:

[2] If PS was used in a controlled experiment comparing two groups, the PS for each participant would be 0.5 because each participant would be randomly assigned to either the treatment or control group with a 50% probability. In observational studies where there is no randomization PS must be estimated.
[3] The difference between the outcomes of treated and control observations, the average treatment effects (ATE) also can be calculated, but in observational studies it may be biased if treated and control observations are not similar.

$$0< \Pr(D=1/x) <1 \qquad (b)$$

Given that Conditional Independence Assumption states and assuming Common Support condition, the propensity score matching estimator for the ATET can be written as follow:

$$ATET^{PSM} = E\,(y1\text{-}y0/p(x), D=1) = E\,(y1/p(x), D=1)\text{-}E\,(y0/p(x), D=0) \qquad (3)$$

Conditional on the propensity score, differences in observed outcomes between treated and control groups can be completely attributed to the intervention.

To estimate the propensity score the first step is to model the probability of being assigned into the treated group. In principle any discrete choice model can be used, but for a binary treatment variable, logit or probit models are either preferred to a linear probability models[4]. Another important decision is the variables included in the estimation of propensity score. In the literature it is recommended to introduce variables that strongly influence the selections into the treatment and outcomes, variables which are statistically significant in the regression model and variables based on economic theory and previous empirical findings.

Estimating the propensity score is not enough to measure the ATET defined in equation (3). The reason is because the probability of two observations (treated and control) have the same propensity score is almost zero since the propensity score is a continuous variable. To overcome this problem, some matching algorithms have been proposed. The four main methods are Nearest-Neighbor Matching, Radius Matching, Kernel Matching, and Stratification Matching. The idea behind matching is for each treated observation we need to find matches of control observations with similar propensity scores. The general concept of each matching estimator is briefly presented in the next lines, for more technical details see Becker and Ichino (2002) and Caliendo and Kopeinig (2008).

The idea of **Nearest-Neighbor Matching** is that each treated observation selects a control observation that has the closest characteristics in terms of propensity score. Several variants of nearest neighbor matching are proposed, e.g. nearest neighbor matching with replacement and nearest neighbor matching without replacement. Matching without replacement consist on each control observation is used no more than one time as a match for a treated

[4] Linear probability models may generate predictions outside the (0,1) bounds of probabilities.

observations and matching with replacement each control observation can be used as a match to several treated observations. However, if the closest neighbor is far away, nearest neighbor matching faces the risk of bad matches. This can be avoided by imposing a radius on the maximum propensity score distance: **Radius Matching**. In Radius Matching each treated observation is matched with control observations that fall within a specific radius.

The idea of **Kernel Matching** is that each treated observation is matched with several control observations, with weights inversely proportional to the distance between treated and control observations. **Stratification Matching** compares the mean difference in outcomes between treated and control observations within blocks (partitions) of propensity scores in the common support.

There is no one method that has been deemed the most appropriate or effective although the bias and variance increases or decreases associated with using each of the propensity score matching methods (Baser, 2006). In general, for large samples all the algorithms should stand the same results but in small samples the matching approach can have a considerable impact. In this case, it is pragmatically that different algorithm forms are tried.

3.2 Data and variables

The main data used in this study were extracted from the "Traffic Map" database which is carried out by the Spanish General Traffic Directorate (DGT) annually. The database contains historically information on accidents involving victims per km, injures and death, average speeds, traffic composition and infrastructure characteristics from national roads and motorways[5]. Since we are only interested in motorway sections (public and private managed), we only use the data collected by the control stations established there, avoiding the use of data related to national roads.

The variable Treatment is if a motorway is managed through a PPP agreement (MGMT). Control stations which are placed in a motorway that is privately managed receives value 1 while those that are placed in a motorway that are managed by the state, receives value 0. A total of 1130 motorway control stations were extracted out of 3010 from the 2008, 2009 and 2010 "Traffic Map 2010", after selection criteria based on complete information for infrastructure characteristics, average speeds, traffic composition and road safety variables.

[5] The database does not contain data on the provinces that belong to the regions of the Basque country, Navarra, Canarias and Baleares Island.

The independent variables to calculate the propensity score are annual GDP per capita (GDP), average annual daily traffic (AADT) and the number of lanes (Lanes). The variables GDP per capita was collected from the Spanish National Statistics Institute database and the variables average annual daily traffic and number of lanes were obtained from the "Traffic Map" database. Additionally**,** in the matching estimation other control variables are included. They are average speed (SPEED), hospitals per square km (HOSP), annual litres alcohol consumption outside of the home (ALCOHOL), total population driving age, total average age vehicle fleets (FLEET) and annual number of rainy days (RAINY). The variable hospitals per square km was available from the Spanish Ministry of Health, the variable annual litres alcohol consumption outside of the home was collected from the Spanish Ministry of Industry, the total population driving age disaggregated by different age group were collected from the Spanish National Statistics Institute database, the total average age vehicle fleets was available from the Spanish General Traffic Directorate and annual number of rainy days was provided by the Spanish State Meteorological Agency. The variable average speed is collected from the "Traffic Map 2010".

The outcomes are the annual number of accidents involving victims per km (AIV), injures (I) and death (D), which are reported by the "Traffic Map" database.

The program used in this study is pscore in STATA, which is developed by Becker and Ichino (2002).

4. RESULTS

This article adopts propensity score matching methodology to estimate the Public Private Partnership effects on the number of motorway fatalities. Table 1 reports the results from a probit linear regression. The dependent variable is the treatment, defined as private management (MGMT) and all the variables that influence the likelihood of being assigned into the treated group such as GDP per capita (GDP), average annual daily traffic (AADT) and number of lanes (Lanes) are included in the probit model to be regressed.

As we can see in table 1, all covariates included in the probit model are significant in the estimation of the propensity score (PS). The PS estimation is done with common support and the number of blocks selected is six[6]. We have checked the common support condition through a visual inspection. The histograms confirmed that there is overlap in the scores

[6] This number of blocks ensures that the mean propensity score is not different for treated and controls observations in each blocks.

between the treatment and control groups. About 95% of total observations are inside the common support, it guarantees that propensity score is not different for treated and controls.

Table 1: The Propensity Score Probit Model

	(2008) MGMT	(2009) MGMT	(2010) MGMT
AADT	-9.15e-06***	-9.57e-06***	-9.09e-06***
	(3.05e-06)	(2.94e-06)	(2.74e-06)
Lanes	-0.294***	-0.243**	-0.165*
	(0.112)	(0.103)	(0.0935)
GDP	0.0794***	0.0731***	0.0774***
	(0.0159)	(0.0157)	(0.0158)
Constant	-0.200	-0.171	-0.595
	(0.527)	(0.500)	(0.472)
Observations	361	380	389

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

By the other hand, to assure that assignment to treatment is independent of the pre treatment characteristics given the same propensity score (conditional independence assumption) it is necessary to test covariate imbalance. The test of balancing property satisfy the balancing condition, therefore the average treatment effect on the treated (ATET) can be estimated.

To estimate the ATET we introduced in the propensity score matching (PSM) specification six new control variables: average speed, hospitals per square km, annual litres alcohol consumption outside of the home, total population driving age, total average age vehicle fleets and annual number of rainy days. The matching algorithms used are: Nearest-Neighbor matching, Radius matching (Caliper 0.20, 0.15, 0.10, 0.05), Kernel matching and Stratification matching.

Table 2 presents the estimations of effects of PPP management on accidents involving victims per km (AIV) in 2008, 2009 and 2010. The observed reduction in annual number of AIV when the observations are unmatched is between 0.976 – 1.010 in absolute numbers and 47.31% – 51.61 in percentages. When applying the PSM method the effects of PPP management on annual number of AIV are reduced. Estimations from nearest neighbor and kernel matching are significant along the period. The results from nearest neighbor matching show a reduction of AIV between 0.363 – 0.87 in absolute numbers and 17.72% – 42.19% in percentages. However, the results from kernel matching are slightly lower than the results from nearest neighbor matching, where the reduction of AIV is between 0.329 – 0.364 in absolute numbers and 15.45% – 18.59% in percentages.

Table 2: Effects of PPP management on accidents involving victims per km (AIV) in 2008, 2009 and 2010.

	2008 (AWV)			2009 (AWV)			2010 (AWV)		
	T-Stat	ATET	% Change	T-Stat	ATET	% Change	T-Stat	ATET	% Change
Unmached	-4.36	-0.999***	48.75%	-4.34	-1.010***	51.61%	-3.72	-0.976***	47.31%
Nearest neighbor	-3.911	-0.363***	17.72%	-2.086	-0.355**	18.13%	-2.36	-0.87**	42.19%
Radius (0.20)	-1.578	-0.353	17.23%	-2.303	-0.349**	17.83%	-1.922	-0.364*	17.65%
Radius (0.15)	-2.179	-0.306**	14.94%	-1.308	-0.279	14.25%	-1.792	-0.332*	16.10%
Radius (0.10)	-2.081	-0.247**	12.06%	-1.282	-0.264	13.49%	-1.461	-0.299	14.50%
Radius (0.05)	-0.789	-0.224	10.94%	-0.776	-0.136	6.95%	-0.654	-0.174	8.44%
Kernel	-2.06	-0.37**	18.06%	-2.296	-0.364**	18.59%	-1.735	-0.329*	15.95%
Stratification	-1.154	-0.248	12.11%	-2.619	-0.335***	17.11%	-1.266	-0.275	13.34%

*** p<0.01, ** p<0.05, * p<0.1

Table 3 presents the estimations of effects of PPP management on injures per km (I) in 2008, 2009 and 2010. The observed reduction in annual number of I when the observations are unmatched is between 1.343–1.555 in absolute numbers and 45.87% – 48.79% in percentages. When applying the PSM method the effects of PPP management on annual number of I are reduced but only the estimations from nearest neighbor are significant along the period. The results from nearest neighbor matching show a reduction of I between 0.705 – 1.494 in absolute numbers and 23.01% – 46.88% in percentages.

Table 3: Effects of PPP management on injures per km (I) in 2008, 2009 and 2010.

	2008 (I)			2009 (I)			2010 (I)		
	T-Stat	ATET	% Change	T-Stat	ATET	% Change	T-Stat	ATET	% Change
Unmached	-4.25	-1.452***	47.40%	-3.69	-1.343***	45.87%	-3.92	-1.555***	48.79%
Nearest neighbor	-4.201	-0.705***	23.01%	-2.168	-0.753**	25.72%	-2.465	-1.494**	46.88%
Radius (0.20)	-1.445	-0.584	19.06%	-1.596	-0.389	13.29%	-2.367	-0.637**	19.99%
Radius (0.15)	-2.524	-0.531***	17.33%	-0.848	-0.285	9.73%	-1.832	-0.583	18.29%
Radius (0.10)	-2.268	-0.426**	13.91%	-0.806	-0.271	9.26%	-1.709	-0.535	16.79%
Radius (0.05)	-0.887	-0.406	13.25%	-0.191	-0.054	1.84%	-0.841	-0.334	10.48%
Kernel	-2.114	-0.647**	21.12%	-1.653	-0.461	15.74%	-2.018	-0.574	18.01%
Stratification	-1.225	-0.406	13.25%	-1.609	-0.337	11.51%	-1.365	-0.491	15.41%

*** p<0.01, ** p<0.05, * p<0.1

Table 4 presents the estimations of effects of PPP management on death per km (D) in 2008, 2009 and 2010. The observed reduction in annual number of D in 2008 when the observations are unmatched is 0.0312 in absolute numbers and 53.25% in percentages. The results are slightly lower in 2009 where the annual number of D reduction is 0.0135 in absolute numbers and 31.56% in percentages. However, results from 2010 are insignificant. When applying the PSM method the effects of PPP management on annual number of D are reduced but only the estimations from nearest neighbor are significant along the period. The results from nearest neighbor matching show a reduction of D between 0.01 – 0.027 in absolute numbers and 17.07% – 94.29% in percentages.

Table 4: Effects of PPP management on death per km (D) in 2008, 2009 and 2010.

	2008 (D)			2009 (D)			2010 (D)		
	T-Stat	ATET	% Change	T-Stat	ATET	% Change	T-Stat	ATET	% Change
Unmached	-4.01	-0.0312***	53.25%	-2.06	-0.0135**	31.56%	-0.68	-0.00392	13.68%
Nearest neighbor	-2.249	-0.01**	17.07%	-2.311	-0.018**	42.18%	-2.032	-0.027**	94.29%
Radius (0.20)	-2.91	-0.022***	37.56%	-1.211	-0.01	23.44%	-0.275	-0.002	6.98%
Radius (0.15)	-3.192	-0.022***	37.56%	-1.398	-0.01	23.44%	-0.595	-0.002	6.98%
Radius (0.10)	-2.313	-0.021**	35.85%	-2.073	-0.01**	23.44%	-0.034	0	0.00%
Radius (0.05)	-1.921	-0.021*	35.85%	-0.999	-0.01	23.44%	0.374	0.003	10.48%
Kernel	-2.319	-0.024**	40.97%	-2.565	-0.013***	30.47%	-0.896	-0.004	13.97%
Stratification	-2.298	-0.019**	32.43%	-2.258	-0.01**	23.44%	0.697	0.004	13.97%

*** p<0.01, ** p<0.05, * p<0.1

5. CONCLUSIONS

The use of Public Private Partnership (PPP) on road sector is increasing around the world due to its ability to fund infrastructure projects and improve efficiency and quality in the provision. However, the effects of private management on road safety have not been yet analyzed. Taking the advantages of the Spanish mixed model of managing and using propensity score matching method, it seems likely that private management might be effectively to improve the quality of the service in terms of road safety.

In fact, we have seen how the annual number of accidents involving victims per km, injures and death are reduced on the motorways which are privately managed. Applying Nearest neighbor matching, results remain consistent along the period. Control traffic stations placed on motorways that are privately managed record about 17% – 42% less number of accidents involving victims per km, 23% – 47% less number of injures per km and 17% – 94% less number of death per km.

For sure, further research is needed to fully understand the reasons behind this positive effect, but it seems that a possible explanation may be related with the level of service contractibility.

Based on the seminal theoretical model developed by Hart et al (1997), the more complete a contract is the more suitable the privatization is without hurting quality. In this regard, it can be stated that the infrastructure management contracts have usually set up a minimum quality standards and if the contractors perform below this quality level, they will be penalized. In case of public management, the penalization does not exist.

In the same lines, when a road accident is caused directly or indirectly by a deficiency of the road, e.g. worn pavement, discontinuities in the fencing, the responsible is the road operator, which has to afford economic compensations to the victims. In public motorways the responsibility is loaded onto the government while in private roads is loaded onto the private company. Consequently, there is a higher motivation for the private operator to establish strategies in order to avoid economic penalties. This grants a higher degree of quality through a more effective management strategy.

Governments should consider these private management strategies in order to improve their road safety outcomes or delegated the management to a private operator.

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