UNIVERSITAT DE BARCELONA

Public-Private Partnerships in Roads: Economic and Policy Analyses

Paula Bel-Piñana

2018

PhD in Economics

Public-Private Partnerships in Roads: Economic and Policy Analyses

Paula Bel-Piñana

PhD in Economics | Paula Bel-Piñana

UNIVERSITAT DE BARCELONA

PhD in Economics

Thesis title:

Public-Private Partnerships in Roads: Economic and Policy Analyses

PhD student:
Paula Bel-Piñana

Advisor:
Daniel Albalate

Date:
April 2018

UNIVERSITAT DE BARCELONA

Als meus pares, Miguel i Maru

Agraïments

Realitzar una tesi doctoral és un procés que necessitat molta il·lusió i persistència i de la qual dediques uns quants anys de la teva vida. Moltes vegades m'he imaginat com seria aquest moment i finalment ha arribat l'hora de dipositar. Tot i que en aquestes circumstàncies són moltes les inseguretats que he deixat enrere, tot i que altres encara subsisteixen, del que estic completament segura és que aquest pas no hagués estat possible sense el suport i consell de tota la gent que m'envolta.

El primer agraïment el vull dedicar al meu director de tesis Daniel Albalate. Aprecio enormement el coneixement que m'ha transmès durant tots aquests anys, la generositat amb la que ho ha fet i la paciència que m'ha tingut. Els bons consells i recomanacions del Daniel han fet possible que arribes aquest gran moment. Moltes gràcies.

També m'agradaria donar les gràcies al Germà Bel. En el meu cas només puc dir que ha estat un plaer el consell acadèmic i suport que m'ha brindat durant tots aquests anys i un goig personal haver pogut treballar junts. Gràcies Germà.

Així mateix, a diferents companys de la secció de Polítiques Públiques de la Universitat de Barcelona. La meva estança a la Torre 6 Planta 3, m'ha permès conèixer a persones magnífiques que tant d'una manera com d'una altra també han fet possible que arribés aquest moment. Marta Gonzalez, Joan-Ramon Borrell, Joan Calzada, Antón Costas, Marc Esteve, Álex Estruch, Lídia Farré, Xavier Fageda, Albert Gragera, Raquel Insa, Eric Jané, Stephan Joseph, Jordi Teixidor, Montse Termes, Rosa Nonell, Sebastian Palacios, Miquel Serra i Carme Vicents. Moltes gràcies a tots.

Menció particular tenen els meus companys de promoció del màster Alberto Antoran, Jordi Rosell, Ángela Mediavilla i Leire Murua per tots els moments que hem compartit molts d'aquests a la facultat i altres tants en viatges. Ha sigut una gran etapa.

Aquesta tesi tampoc hagués estat possible sense el suport dels meus estimats amics de doctorat Valeria, Tania, Max i especialment Carlitos amb els qui a part de discutir freqüentment sobre els temes tractats en aquesta tesi també he compartit fantàstics moments personals. Moltes gràcies a tots, sou genials.

També m'agradaria donar les gràcies a Richard Geddes per haver-me acollit al Cornell Program of Infrastructure Policy a la Universitat de Cornell durant la primavera del 2013. La primera part del segon capítol d'aquesta tesi, neix fruit d'aquesta estança. Moltes gràcies per brindar-me aquesta oportunitat.

No vull finalitzar aquests agraïments sense recordar a les meves amigues del poble, especialment a la Vanesol, Jes, Ju, Aina i Neus, ni tampoc a la secció del Raval: Lara, Gemma i Belén. Molts gràcies a vosaltres també per acompanyar-me durant tots aquests anys.

Menció especial es mereix la meva estimada iaia Felisa i la meva tia Cinta. Malauradament no podran estar a la defensa de la tesi però sense elles res hagués estat igual. Moltes gràcies per tota l'amor que m'heu brindat.

Finalment, dedico la tesi als meus pares Miguel i Maru per tot el seu suport, ànims i recolzament que m'han donat tota la vida. Sou uns pares meravellosos, no canvieu mai. Moltes gràcies.

Contents

Chapter 1

Introduction

1. The Role of PPPs in Road Infrastructures

In recent decades, public-private partnerships (PPPs) has converted in an alternative way of providing transport infrastructures that has been traditional delivered by public sector. Between 1990 and 2017, governments all over the world have awarded more than 1600 PPPs transport infrastructure projects with a total investment of 457,655 B euro.[1] However, the management and financing of road infrastructures by means of PPPs has aroused the greatest interest. Figure 1 shows the number of airports, roads, ports and railway PPPs projects and the total investment made in the world from 1990 to 2017. The figure shows that, since 1990, road sector has attracted most of infrastructure projects and resources.

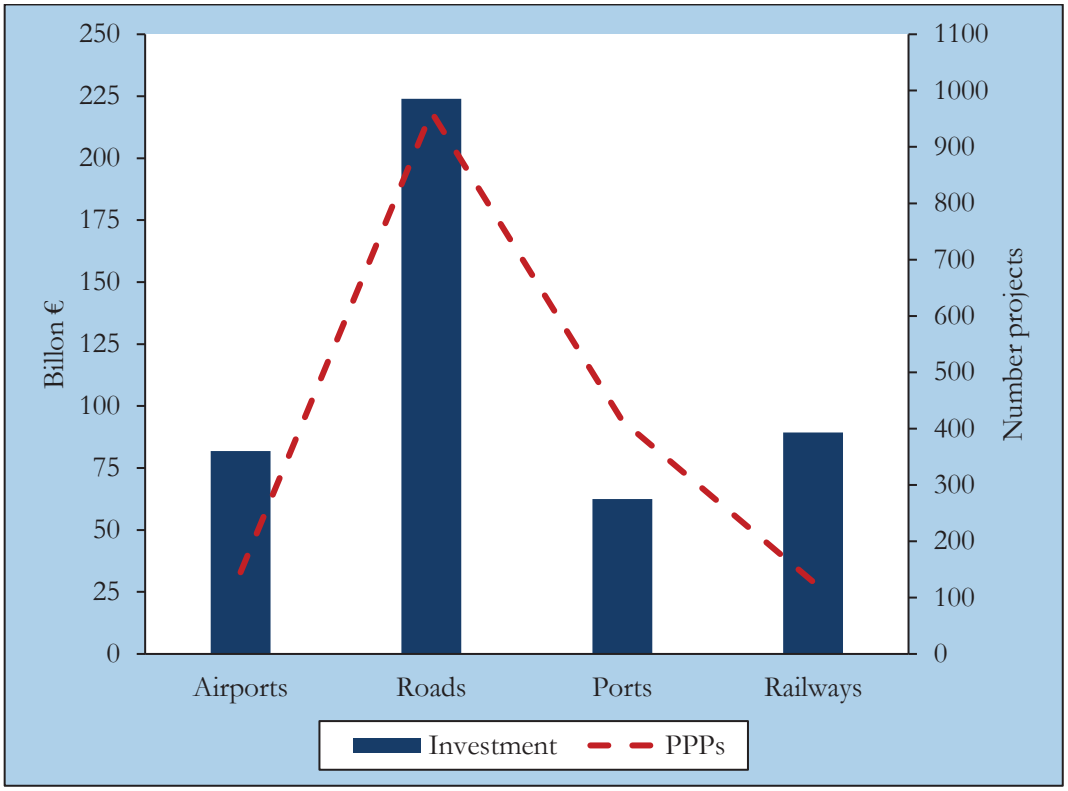
The rationale for adopting road PPPs differs with the variety of national needs. In southern and eastern Europe and more recently in the United States, the need to reinvest in the maintenance of deteriorated roads or to expand current networks coincided at a time of severe budgetary constraints, prompting governments to seek private financing (Holeguín-Veras et al., 2006; Bel and Foote, 2009; Albalate et al., 2009). In Latin America economies such as Chile, Argentina and Brazil, among others, the infrastructure sector reform processes initiated in the early 1990s and the need to decongest heavily trafficked corridors led many countries to adopt measures to attract private capital (Carpintero, 2002; Engel et al., 2006b; Guasch, Laffont and Straub, 2008; Engel et al., 2009a; Engel et al., 2009b).

The financing and maintenance of road infrastructure through PPPs has become an important complement to traditional public procurement (Hodge et al., 2010; Albalate, 2014). However, arriving at a definition of the term is complex, given that each country adapts the definition according to its own institutions and jurisdiction. In general terms, PPPs are contracts in which the state awards the project to a private company, which undertakes several tasks

[1] The World Bank database.

that include to build and/or maintain and finance the project for a stipulated period of time. When the concession period ends, the infrastructure reverts to state (Grimsey and Lewis, 2004). The concessionaire's profits depend directly on the profits it makes during the operating period. Typically, these benefits are obtained by charging users directly through direct tolls or through public transfers to the concessionaire, such as shadow tolls or availability payments (Abdel Aziz, 2007a; Iossa et al., 2007).

Figure 1. Number of PPPs projects and total investment in different transport sector in the world 1990-2015



Source: Based on data from the World Bank.

There is currently a wide variety of PPP contracting models, such as BOT (build, operate and transfer), BOOT (build, own, operate and transfer), BTO (build, transfer and operate), DBOT (design, build, operate and transfer) and ROT (rehabilitate, operate and transfer) (GAO, 1999; Delmon, 2010; World Bank, 2012). However, for a more detailed understanding of the different PPP models, it is necessary to define a series of essential elements such as the type of investment required by the project, the tasks that are carried out during the concession period and the risks that will be borne by both parties.

Two types of investment can be distinguished in respect to the type of investment required in the project. Investment in the construction of new road infrastructure is known as a greenfield project and investment in existing roads for rehabilitation or expansion of capacity is considered a brownfield project. Implementing a greenfield project is more complex and expensive than a brownfield project (Bitsch al., 2010). The first type of project requires much higher levels of investment, since the project must be carried out from scratch and during this process additional construction costs may arise from unexpected terrain conditions, expropriations, or delays in obtaining permits. Furthermore, the uncertainty related to traffic demand is much greater than in brownfield projects, so that the level demand of return on profits and risk taking is higher in the former than in the latter.

Regarding the tasks that will be performed during the concession period, it is imperative that the contract includes different tasks to differentiate itself from mere outsourcing (Grimsey and Lewis, 2004; Hodge et al., 2010). With task bundling, the private partner has incentives to incorporate in its objective function the entire set of assigned tasks and to take advantage of the complementarity between them. For this to happen, must be carried out by a single company or consortium of companies that contract and operate jointly (Bennet and Iossa, 2006). The private sector is awarded a single contract for the construction and operation or rehabilitation and maintenance of the infrastructure. The term of the concession will be determined by the type of contract demanded. However, a more restrictive approach requires that task include both construction and operational tasks (Martimort and Puyet, 2008; Engel et al., 2014). In terms of Albalate, Bel and Geddes (2017), the first case would be defined by a strong vertical integration, while packaging that only groups construction or operation and maintenance tasks in an exclusive way would define a weaker vertical integration.

Finally, another essential component of PPPs is the sharing of risks between the parties (HM Treasury, 2003; OECD, 2008; Hodge et al., 2010). Contract theory establishes as a general rule that risk must be assigned either to the party with the greatest relative control over it or to the party that is best able to bear it in high-risk aversion scenarios (Engel et al; 2014). In the academic literature on risk sharing in PPP contracts there is consensus that global risks (legal, environmental and political risks) should be borne by the public sector, while elementary risks (operational and financial risks) should be borne by the private sector (Grimsey and Lewis, 2002; Lilley and DeGiorgio, 2004). Poor adherence to these criteria could have negative effects on taxpayers.

1.1 Optimal Distribution of Risk in Road PPP

A key element for a successful PPP project is the correct allocation of risks between the public and private sectors (Abdel Aziz, 2007b; World Bank, 2012). In order to achieve optimal risk sharing in PPPs, however, a thorough review is necessary of both the incentives created by the contractual relationship between the parties and the risks borne by them. To some extent, risks and incentives are grouped into a PPP according to the standard principal-agent theory (De Palma et al., 2009). This conclusion means that risks should be distributed according to the control and knowledge capacity of the different parties. However, in order to allocate risks correctly, it is necessary to create incentives between the parties and to allocate guarantees against risks (Iossa et al., 2007).

Consequently, given that private companies maximize profits and know the business, they have greater incentives to prevent any risks they might have to bear in relation to financial risk, construction risk, maintenance risk and demand risk. In this case, it makes perfect sense to agree on a contractual transfer of these risks to the private sector, as they can be successfully controlled by that sector. By adopting this strategy, companies have incentives to devote all their efforts to control these risks in order to minimize the negative impacts on expected profitability. If the company has sufficient instruments and incentives to eliminate or minimize uncertainty, then the optimal strategy for improving the performance of PPPs involves transferring financing and operation risks to the private sector.

Some risks, however, cannot be controlled by the private sector, such as the legal risk that includes the risk of expropriation and technological progress and the risk of force majeure that includes environmental and political risk. In some circumstances, the private sector does not have sufficient instruments to manage the variables underlying uncertainty and profitability expectations, which may result in the failure of the project. In these cases, the literature on optimal contracting states that the government should play a role in protecting against these risks, which are difficult for the private sector to control.

Several studies provide sound guidance for risk allocation in PPP projects (Yescombe, 2007; Phillips, 2008; Delmon, 2009). From these, it is clear that incentives must be provided for the risks potentially controlled by the private sector and protection must be provided for the remaining risks.

Table 1 shows the primary risks that exist in road projects and their optimal distribution among agents. It emphasizes the need to transfer risk to the private sector in the case of activities under that sector's control, but to mitigate risk with state guarantees for those that go beyond the control limits of the private

sector. Risk transfer promotes efficient private sector behavior at each stage of the PPP project, while public sector protection in all other risk areas serves to achieve lower capital cost through risk mitigation.

Table 1. Optimal distribution of risk in road PPPs

Risk	**Private**	**Public**
Construction risk		
Design project presented in call to tender		X
Project planning	X	
Permits execution of construction works		X
Increase in the price of inputs	X	
Changes to output requirements		X
Drawing delays	X	
Land acquisition risk		
Expropriation		X
Need additional land after commercial close	X	
Maintenance risk		
Cost overrun	X	
Quality and performance	X	
Traffic accidents	X	
Standards supervision of performance		X
Workers strikes or disputes	X	
Traffic demand risk		
Lower or higher traffic than expected	X	
Investment in a parallel road infrastructure		X
Financial risks		
Interest rates	X	
Exchange rates	X	
Inflation	X	
Subcontractor insolvency	X	
Force majeure risk		
Interruption in the operation by natural disasters		X
War		X
Social protests and demonstrations		X
Technological progress risk		
Information in regulatory changes		X
Technology update according to current regulations	X	

Source: Adapted from Albalate (2014).

1.2 Advantages of Road PPPs

There are several reasons why road PPPs have been employed as a good alternative to traditional public provision. One of the most common is the advance financing they provide to the public sector at a time of severe budgetary constraints (Grimsey and Lewis, 2002). Public sector borrowing restrictions, especially in periods of recession, limit infrastructure spending projects. With private participation, the government has assets available for public use with no impact on its short-term budgetary balance. This has been particularly relevant in the road infrastructure sector (World Bank, 2011). Several empirical studies have shown that the use of PPPs increases when the state of public finances weakens (Hammami et al., 2006; Russo and Zampino, 2010; Albalate et al., 2017). However, for the assets of a PPP not to be recorded in the accounts of the public administration, the construction risk and the demand or availability risk should be borne by the private sector (Eurostat, 2016).

Another of the most frequently used arguments in favor of PPPs is the potential improvement in economic efficiency derived from private management (Grimsey and Lewis, 2002; World Bank, 2012). In this case, maximizing private profit through cost savings is what would provide such efficiency gains. On the other hand, it has also been suggested that it is the private sector's greater innovative capacity that allows governments to achieve their public service objectives at lower cost (Bettignies and Ross, 2009). However, the empirical literature that has attempted to analyze the relationship between ownership and efficiency is limited for the road infrastructure sector. The studies show inconclusive results on the relationship between ownership and efficiency (Blanc-Brude et al., 2009; Raisbek et al., 2010; Chasey et al., 2012).

Finally, another frequently used reason has been the expected improvements in quality of service derived from PPPs (Harris, 2004; Hodge and Greve, 2007). In this sense, the European Commission (2003) states that the quality of service in PPPs is superior to traditional provision thanks to the innovative capacity introduced by the private sector, the greater use of economies of scale, better integration of services and the possibility of introducing performance-based contracts. Indeed, the World Bank (2012) argues that in order for quality to increase, it is essential for the PPP contract to clearly specify what is expected from the private sector in terms of asset quality and quantity and the service provided. However, in the road sector the introduction of incentives through performance-based contracts is relatively new and studies are still very scarce (Rangel et al., 2012;2013; Rangel and Vassallo, 2015).

Lastly, the theory of property rights based on incomplete contracts warns that incentives for private management to reduce costs could have negative effects on quality (Hart et al., 1997; Hart, 2003). In sectors such as water and healthcare, several empirical articles have tried to show the effects of management on quality. For water supply, studies show that PPPs have contributed to improved quality of service (Galiani et al., 2005; Marin, 2009; Nassima, 2012). For healthcare services, the effects found are inconclusive (Shortell and Hughes, 1988; Hartz et al., 1989; Keeler et al., 1992). However, no empirical report has explored the effects of management on road safety.

1.3 Disadvantages of Road PPPs

Despite all the benefits associated with PPPs, recent experience shows that there are several problems that can affect the successful implementation of these collaborations. In fact, one of the biggest disadvantages encountered is frequent renegotiations. Indeed, in Guasch (2004) we find that an elevated 78.4% of road concessions in Latin America were renegotiated before entering into service. These results are very similar to those found by Engel et al (2009a) for Chile, where most infrastructure contracts were renegotiated before going into operation. Or those Baeza and Vassallo (2008a) have found for Spain, where almost 44% of motorway concession contracts were renegotiated within the first five years of the award.

There are four main reasons for the frequent renegotiations. First, the poor design of the contracts due to their incomplete nature (Kerf et al., 1998). Second, a defective bidding process and/or opportunistic behavior (Athias and Nuñez, 2008). Thirdly, poor prediction models that find it difficult to estimate correctly the evolution of traffic over the long term. (Bain, 2009). Fourth, rigidity in the duration of the concession (Engel et al., 1997, 2001; Nombela and De Rus, 2001).

In relation to the first reason, it can be argued that a PPP contract is a long-term contract. This means that contingencies may arise during the contractual relationship that were not contemplated at the time of the award. These contingencies are what limit a complete design of the contract. If the initial conditions vary, two things can happen. One is the modification of the initial contract and the second is a renegotiation of the concession terms. What the theory of incomplete contracts shows is that modifying contracts involves high transaction costs (Coase, 1937; Williamson, 1971; Tirole, 1999). Therefore, renegotiating in the face of contingencies may be less costly than modifying contracts or attempting to make them more complete (Engel et al., 2003a).

As regards the tender procedure, given that road infrastructures present characteristics of being a natural monopoly and the fact that there is no competition in the market but rather for the market (Chadwick, 1859), the practice accepted worldwide is the allocation of concessions by means of first-price auctions with closed envelopes. This model theorized by Demsetz (1968) incorporates competition through auctions and ensures that the winning company is the most efficient[2]. In practice, this form of allocation presents serious problems since once the concession has been awarded to the company by the state, the infrastructure becomes a bilateral monopoly and the efficiency and transparency achieved in the competitive auction for the contract is lost (Williamson 1976, 1985). After the allocation of the concession by auction, the relationship between the state and the company becomes a bilateral monopoly and involves risks for both parties. On the one hand, it implies risk for the company insofar as there is a risk from the state, which may modify the expected conditions of the business and generate losses or lower profits for the firm. On the other hand, the firm knows that the state has commitments to the success of the concession and that the failure of the concession can lead to major political problems. The concessionaire is therefore tempted to put pressure on the state to improve its economic situation, knowing that the former may yield in keeping with its political restrictions.

Another problem resulting from the bidding procedure is the opportunistic behavior that companies participating in the tender may adopt. For example, Athias and Nuñez (2008) have analyzed auction procedures in 49 road concessions around the world. The results of their research show that companies submit more aggressive bids when they estimate a lot of competition in the auction. In contrast, these offers are more strategic in institutional frameworks where renegotiation is easier.

The third problem focuses on errors in predicting expected traffic demand. In this case, Bain (2009) analyzes more than 100 international road projects financed with a private budget. The results of his research show that the error bias found in traffic estimates is very high. In the case of Spain, Baeza and Vasallo (2008a) demonstrate that the companies bidding for the tender overestimate the expected traffic demand. This fact is directly associated with

[2] The central idea underlying this practice is found in the work of Demsetz (1968) and stemming from the basic idea of competition for the market that Chadwick was already proposing (1859). The work suggests that natural monopolies can be assigned through an auction to the bidder who offers to charge the lowest price guaranteeing the efficiency of the winner.

the numerous renegotiations that have taken place in this country since the mid-1970s.

Indeed, the literature shows that nothing guarantees that the winner of the competition will be the most efficient company. If the auction is won by the company that has most overestimated traffic (erroneously or strategically so that it can then renegotiate) and subsequently traffic is not in fact what was expected (it is less), the company will suffer losses and exert pressure on the state to renegotiate (Engel et al. 2009).

Finally, another problem that increases the frequency of renegotiations is the rigidity generated by fixed-term contracts. Let us imagine that traffic demand grows faster than expected. In this case, it may be desirable to end the concession in order to avoid extraordinary profits and overpayment by users or taxpayers. However, this is not easy when the concession term is fixed, since the appropriate compensation that should be given to the concessionaire for ending the concession term earlier than agreed is very difficult to calculate (Engel et al., 2009).

In order to alleviate the problems associated with fixed-term tenders, some authors such as Engel et al. (1997, 2001) and Nombela and De Rus (2004) have proposed mechanisms for variable duration of the concession according to the evolution of demand. For the Spanish case, Albalate and Bel (2009) carry out empirical work on the desirability of applying flexible concession duration mechanisms depending on the evolution of demand. The results show that applying these mechanisms in the face of uncertain traffic demand would have reduced the completion period for the two oldest toll concessions in Spain, avoiding the extra cost for users and the extraordinary profits of the concession company.

There is currently no academic article assessing the social and distributive impact of these renegotiations on society, although it is well known that the type of renegotiations carried out in Spain have not been very transparent, (Beza and Vassallo, 2008) have affected rates (Bel and Fageda, 2005), the concession period (Baez, 2008) and the economic-financial benefits of the concessions (Bel, 1999; Baeza and Vassallo, 2008a).

2. Road PPPs in Spain's Toll Motorways

The first major public initiative to provide Spain with a high-capacity road network occurred in the late 1920s under the dictatorship of General Primo de Rivera. In 1928, under the General Law on Public Works of 13 April 1877 and the General Law on Roads of 4 May 1877, the state authorized the concession for the private financing of the toll motorways of Madrid-Irún, Madrid-Valencia and Oviedo-Gijón. However, although state subsidies were foreseen, the project was not carried out. Expectations of traffic demand were still insufficient to encourage private sector participation. In addition, with the arrival of the Second Republic in 1932 and later the Spanish Civil War, the Spanish economy was submerged in a period of great depression. Spain's non-intervention in World War II distanced it from post-war European recovery plans and left it in a situation of complete isolation. After the Civil War, Spain adopted a model of internal development known as autarchy, closing its borders to the entry of foreign goods, services and capital. The development of high-capacity roads had to be postponed.

In the early 1950s, after the approval of the Plan for the Modernization of Roads of 1950 and the Law 26/1953 on the Construction of Toll Roads of 26 February 1953, a second attempt was made to improve road infrastructure. However, the lack of sufficient economic resources on the part of the state meant the attempt was again doomed to fail. Under this law, only the construction of the Guadarrama Tunnel under the Alto del Puerto de los Leones de Castilla managed to be awarded to the private sector. It was quickly noted that this law had a number of shortcomings related to the absence of rules concerning the fiscal and economic-financial system of concessions and did not foresee any type of state aid or subsidy.

In the late 1950s, after the approval of the 1959 Stabilization Plan, the Spanish economy began to grow strongly. This remarkable growth considerably increased the need for infrastructure, especially roads. In order to meet this demand and given the country's financial limitations, a new road law was passed in 1960, Law 55/1960 on Roads under Concession of 22 December. This new legislative framework made private participation more attractive as it incorporated subsidies from the state and a whole range of tax reliefs and exemptions.

In the context of this new scenario, in 1965 the first major toll motorway program, the Programa de Autopistas Nacionales Españolas, PANE, was launched. This program provided for the construction of 3,160 kilometers of high-capacity roads, which generated high economic and social expectations.

However, the incomplete legal framework in force meant that the first awards were made by means of specific decree-laws. Between 1967 and 1972, the private sector was awarded nine state toll road concessions: the motorways Barcelona-la Junquera, Montgat-Mataró, Bilbao-Behovia, Villalba-Villacastín and Villacastín-Adanero, Barcelona-Tarragona, Sevilla-Cádiz, Tarragona-Valencia and Valencia-Alicante. For the award of these concessions, the state guarantees already provided for in Law 55/1960 were maintained and state guarantee and exchange insurance were also incorporated.

From 1972 onwards and with a total of 887 kilometers of state toll motorways awarded, it was not possible to continue advancing with the PANE without a well-established regulatory framework. The Law 8/1972 on the Construction, Maintenance and Operation of Motorways under a Concession System of 10 May 1972 was passed in mid-1972 and subsequently, in 1973, the decree regulating the general clauses, Decree 215/1973 Approving the List of General Clauses for the Construction, Conservation and Operation of Motorways under a Concession System of 25 January.

The legislative approval of this elaborate regulatory framework quickly led to the award of the second toll motorway package programmed in the PANE. Between 1972 and 1976, seven new state toll motorways (948 km) were awarded to the private sector: Villacastín-Adanero, Zaragoza-Mediterranean, El Ferrol-Portuguese Border, Bilbao-Zaragoza, Montmeló-El Papiol, Burgos-Málzaga and León-Campomanes.

From 1976 onwards, private financing of toll motorways was paralyzed due to the political and economic changes brought about by the country's transition and the oil crisis. The economic crisis radically changed expectations of profitability arising from the construction and operation of motorways. Rising interest rates increased construction costs and traffic demand slowed as the busiest corridors had already been awarded during the dictatorship (Matas and Raymond, 1999; Bel and Fageda, 2005). As a result of this situation, the concessionaires of the León-Campomanes, El Ferrol-Portuguese Border, Irurzun-Tudela, Sevilla-Cádiz and Zaragoza-Mediterranean motorways were unable to meet their financial obligations. Faced with the risk of bankruptcy, the government decided to nationalize several companies and restructure the sector. In 1984, the public company Empresa Nacional de Autopistas, ENA, was created and the state toll motorways León-Campomanes and El Ferrol-Portuguese Border were nationalized.[3] The restructuring of the sector also

[3] The autonomous community motorway of Irurzun-Tudela was also nationalized through the purchase of 50% of its shares.

meant that the two largest companies in the sector, AUMAR and ACESA, absorbed the concessionaires of the Seville-Cádiz and Zaragoza-Mediterranean motorways. To compensate for the takeover, the government granted them an extension of the concession period and an increase in toll rates. This was the first major political renegotiation of the sector.

After the democratic transition and during the period of government of the Socialist Party (1982-1996) infrastructure policy changed completely. The financial situation that had caused the economic crisis in the sector led to a rethink of road infrastructure policy. In 1985, the state approved a new road plan, the General Road Plan. This new plan prioritized the construction of free motorways through public funding and halted the award of new toll motorways to the private sector. With Spain's entry into the European Economic Community in 1986, the plan obtained a significant economic boost, which enabled it to meet the new challenges of the Spanish economy. In addition, in 1988, Law 25/1988, of 29 July on Roads repealed the exchange insurance and the state guarantee.

However, in order to save costs, the first generation of high-capacity public roads (motorways) was built by duplicating existing lanes. By the end of the 1980s, more than 2,000 km of publicly funded motorways had been built, as well as more than 1,800 km of motorways through public-private partnership contracts.

In the early 1990s, the socialist government was forced to adjust the state deficit as a result of the agreements adopted in the Maastricht Treaty, which limited the possibilities of obtaining financing from the public budget. In 1993, a new Infrastructure Master Plan 1993-2007 was presented, which envisaged the construction of 4,900 kilometers of new freeways and motorways. However, the national election and the change of the party in power prevented the full development of this plan.

After 1996, with the entry into government of the People's Party (Partido Popular, PP), the policy of spending in transport infrastructure changed completely. Although freeways continued to be built, toll motorways were once again the focus of attention. In December 1996, the Law 13/1996 of 30 December 1996 on Fiscal and Social Measures was approved as a matter of urgency, which granted the state the possibility of making subordinated loans or ones of other characteristics to infrastructure concessionaires in order to guarantee their economic and financial viability, as well as the possibility of modifying the concession periods if the government introduced changes in both contracted services and toll rates. Between 1996 and 1999, all concession

contracts awarded during the dictatorship were extended[4] and 390 new kilometers of toll motorways were built. The Málaga-Estepona, Alicante-Cartagena, Santiago-A. S. Domingo, Estepona-Guadiaro, R-3 Madrid-Arganda, R-5 Madrid-Navalcarnero, Ávila-Villacastín, Segovia-San Rafael and León-Astorga. Figure 2 shows all the road sections that have had at least one concession period renegotiation. The figure shows the number of renegotiations that each road section has had over time along with the years of extension that each modification has required.

While this strong wave of political renegotiations took place and new concessions were granted to the private sector, the government passed another ambitious infrastructure plan, Infrastructure Plan 2000-2007. Between this new plan and the consolidated text of the Public Administration Contracts Law, the Royal Legislative Decree 3/2011 of 14 November, Approving the Consolidated Text of the Public Sector Contracts Law and the Law 13/2003, of 23 May Regulating the Public Works Concession Contract, 491 kilometers of new concessions were awarded to the private sector: the R-2 Madrid-Guadalajara, R-4 Madrid-Ocaña, Eje Aeropuerto, Cartagena-Vera, Ocaña-la Roda, Madrid-Toledo, Circunvalación de Alicante and the Alto de las Pedrizas-Málaga. In all the awarding decrees of these concessions[5], the amount that should be paid by the state to the concessionaire in the event of the concession's bankruptcy is explicitly quantified. Table 2 shows all the national toll motorway concession companies, the sections of motorway they consisted of at the time of their award, the date of award corresponding to the date published in the Official State Gazette (BOE, in its Spanish acronym), the period of termination of the concession, and the years of operation agreed between the state and the concessionaire at that time.

Since 2006 and up to the present, no further private constructions have been commissioned. At the end of 2007, however, 1,000 km of first-generation motorways were transferred to private companies for a period of 19 years. The increase in traffic flow, speed and the number of accidents in this first generation of public motorways led the government to opt for private management. The eruption of the recent crisis, however, caused many of the motorways awarded during the period 1998-2006 to go bankrupt.

Currently, Spain has an extensive network of high-capacity roads, 11,379 km of which belong to the state. 76% are publicly managed and 24% are managed by private companies through public-private partnership contracts.

[4] With the exception of IBERPISTAS.
[5] With the exception of the Alto de las Pedrizas-Málaga motorway.

Figure 2. Toll motorway renegotiations of concession contracts awarded by the central government of Spain

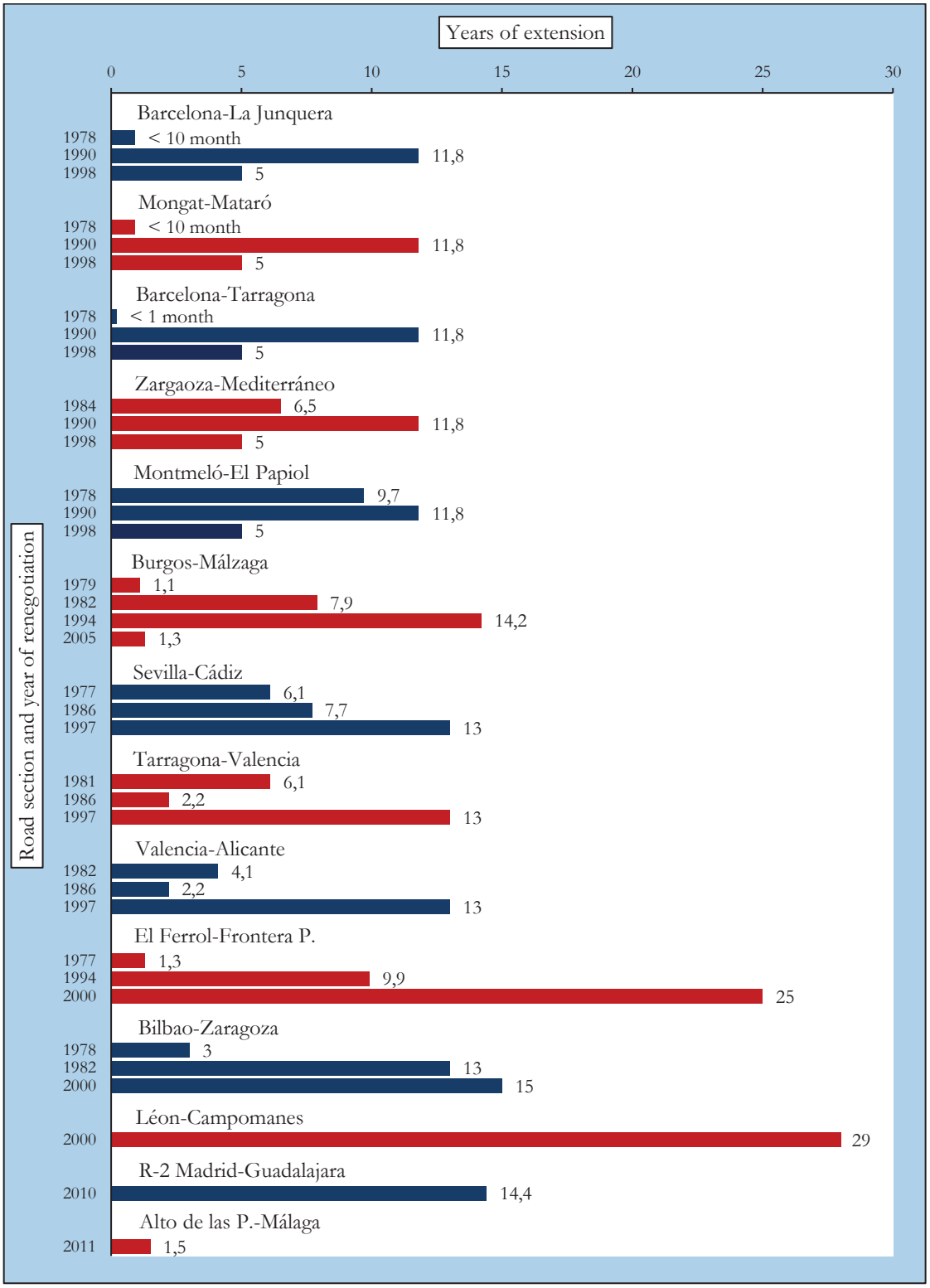


Table 2. Toll motorway concession companies awarded by the central government of Spain

Concessionaire	Road	Km	Award	Final date award	Years	Actual final date	Total years
ACESA	Barcelona-La Junquera	150	06/02/1967	06/02/2004	37	31/08/2021	54
	Mongat-Mataró	15	06/02/1967	06/02/2004	37		54
	Barcelona-Tarragona	100	29/01/1968	29/01/2005	37		53
	Zargaoza-Mediterráneo	215	25/06/1973	25/06/1998	25		48
	Montmeló-El Papiol	27	15/05/1974	15/05/1995	21		47
IBERPISTAS	Villalba-Villacastín	39	29/01/1968	29/01/2018	50	19/11/2031-36	63-68
	Villacastín-Adanero	31	30/09/1972	29/01/2018	46		59-64
EUROPISTAS	Bilbao-Behovia	115	23/03/1968	05/06/2003	35	-	35
	Burgos-Málzaga	84	26/06/1974	26/06/1994	20	31/11/2018	44
AUMAR	Sevilla-Cádiz	94	30/07/1969	30/07/1993	24	31/12/2019	50
	Tarragona-Valencia	225	08/09/1971	08/09/1998	27		48
	Valencia-Alicante	149	22/12/1972	22/12/1999	27		47
AUDASA	El Ferrol-Frontera P.	219	18/08/1973	19/08/2012	39	18/08/2048	75
AVASA	Bilbao-Zaragoza	294	10/11/1973	10/11/1995	22	10/11/2026	33
AUCALSA	Léon-Campomanes	78	17/10/1975	17/10/2021	46	17/10/2050	75
AUSOL	Málaga-Estepona	83	15/03/1996	15/03/20 46	50	-	50
	Estepona-Guadiaro	22	01/07/1999	01/07/2051	52		52

Table 2. (*Continued*)

Concessionaire	Road	Km	Award	Final date award	Years	Actual final date	Total years
AUSUR	Alicante-Cartagena	77	01/08/1998	01/08/2048	50	-	50
AM	R-3 Madrid-Arganda	34	06/10/1999	06/10/2049	50	-	50
	R-5 Madrid-Navalcarnero	28	06/10/1999	06/10/2049	50		50
ACEGA	Santiago-A.S.Domingo	57	12/11/1999	12/11/2074	75	-	75
CASTELLANA DE AUTOPISTAS	Ávila-Villacastín	23	18/11/1999	19/11/2031-36	32-37	-	32-37
	Segovia-San Rafael	28	18/11/1999	19/11/2031-36	32-37		32-37
AULESA	Léon-Astorga	38	10/03/2000	10/03/2055	55	-	55
HENARSA	R-2 Madrid-Guadalajara	81	04/11/2000	04/11/2024	24	25/03/2039	39
AUTOPISTA MADRID SUR	R-4 Madrid-Ocaña	88	30/12/2000	30/12/2065	65	-	65
EJE AEROPUERTO	Eje Aeropuerto	9	26/11/2002	26/11/2027-28	25-26	-	25-26
AUTOPISTA COSTA CÁLIDA	Cartagena-Vera	77	14/02/2004	14/02/2040-44	36-40	-	36-40
AUTOPISTA MADRID-LEVANTE	Ocaña-La Roda	118	21/02/2004	21/02/2040-44	36-40	-	36-40
AUTOPISTA MADRID-TOLEDO	Madrid-Toledo	60	21/02/2004	21/02/2040-44	36-40	-	36-40
CIRALSA	Circunvalación de Alicante	33	21/02/2004	21/02/2040-44	36-40	-	36-40
AUTOPISTA DEL GUADALMEDINA	Alto de las P.-Málaga	25	27/09/2006	27/09/2042-45	36-39	27/02/2044-47	38-41

3. Structure and Objectives of this Thesis

The description given in the previous sections demonstrates the value of analyzing in a more detailed way several aspects that affect public-private partnerships in road infrastructures and which could facilitate the study of their economic impact. Spain is a good context for analysis, both because of its pioneering nature in the extension of such public-private partnerships and because of the undisputed weight of the road infrastructure industry in the international context. This pioneering character, which began in the mid-1960s, provides Spain with a long experience in the contractual design of the relationship between the state and the private sector in the field of high-capacity road infrastructures. Moreover, since the end of the 1990s, Spain has experienced the most widespread program of renegotiations of the concession period as a public policy mechanism, although these renegotiations have led to significant reductions in rates, leaving users committed for a longer period of time. Another characteristic element that makes Spain a good context for analysis is the mixed composition of management and financing of high-capacity roads.

The thesis is structured in five chapters of which the introduction is the first. The second chapter is divided into two sections. The first examines and compares in a historical perspective how the main risks and guarantees have been distributed in PPP contracts in Spain and other countries such as Chile, France, Argentina, Brazil and Poland. The second part assesses the extent to which the Spanish model of risk and guarantee allocation may have played a part in the financial problems currently faced by many concessionaires. The third chapter assesses the impact of political renegotiations carried out since the late 1990s in Spain. The fourth chapter analyses whether public-private partnerships in Spain contribute to increasing the quality of service provision in terms of road safety. Finally, chapter five presents the conclusions and some public policy recommendations.

Chapter 2 has two aims. The first part of the chapter seeks to analyze whether the allocation of risks that has been carried out in Spain and other countries complies with the predictions of contract theory. To this end, the framework of institutional and economic relations between the state and private concessionaires is reviewed in detail. The purpose of this case analysis is to identify the main limitations of these models and to delineate those aspects that have a significant influence on the incentives of the different parties, the efficiency of the contract, the financial evolution of the concession and its impact on public finances, taxpayers and users. Additionally, good regulatory practices are suggested in the concession business, which make it possible to

take advantage of the benefits that private participation in road infrastructure projects can bring.

The second part examines whether the financial downturn experienced by most concessions awarded at the beginning of the new millennium can be attributed to Spain's particular model of risk sharing and guarantees. This analysis intends to shed light on the debate on possible solutions to the crisis in the sector.

The first part of the chapter has been published as *Risk Mitigation and Sharing in Motorway PPPs: A Comparative Policy Analysis of Alternative approaches* in Journal of Comparative Policy Analysis, 17 (5), pp. 481-501. The second part of the chapter has been published as *Tropezando dos veces con la misma piedra: quiebra de autopistas de peaje y costes para contribuyentes y usuario* in Revista de Economía Aplicada, 23 (67), pp. 131-152.

Chapter 3 aims to quantify and evaluate the social and distributive impact of one of the last political renegotiations, which took place in 1997 between the state and the concessionary company that managed them. Specifically, the case of the renegotiation of the concession contracts for the AP-7 motorway in its sections between Tarragona-Valencia and Valencia-Alicante is illustrated. In order to carry out this study, use has been made of the methodology for calculating the change in well-being resulting from the renegotiations. This approximation allows us to compare the real status quo situation with renegotiation, with the alternative that would have been not to renegotiate and delimit the monetary impact of such renegotiations for each of the agents involved and for the added social well-being.

This chapter has been published as *Winners and Losers in Toll Motorway Renegotiations: An Empirical Evaluation of the Spanish Pioneers* in Public Money & Management, 36(5), pp. 365-372.

The aim of chapter 4 is to analyze whether the type of management on high-capacity roads has any impact on road safety. We will use the Spanish case as an analysis model. Spain's mixed composition of high-capacity roads is an excellent opportunity to empirically test whether private road management through PPP contracts offers better quality than traditional provision. To this end, we apply different econometric techniques based on tallying data on a data panel for the period 2008-2012.

In late December 2017, this chapter has been submitted in Accident Analysis and Prevention as *Public Private Partnership Management Effects on Road*

Safety Outcomes. The editor invited me to respond to the reviewers' minor comments and resubmit the article before April 17.

Lastly, the aim of chapter 5 is to extract the most important conclusions from the previous chapters and to provide some public policy recommendations based on them.

References

Abdel Aziz, A.M., 2007a. A survey of the payment mechanisms for transportation DBFO projects in British Columbia. Construction Management and Economics, 25(5), 529-543.

Abdel Aziz, A.M., 2007b. Successful Delivery of Public-Private Partnerships for Infrastructure Development. Journal of Construction Engineering and Management, 133(12), 918-931.

Albalate, D., 2014. The Privatisation and Nationalisation of European Roads: Success and failure in Public Private Partnerships. Cheltenham: Edward Elgar.

Albalate, D., Bel, G., Fageda, X., 2009. Privatization and regulatory reform of toll motorways in Europe. Governance 22(2), 295-318.

Athias, L., Nuñez, A., 2008. Winner's curse in toll road concessions. Economic letters 101(3), 172-174.

Baeza, M.A., Vassallo, J.M., 2008a. Renegociaciones de los contratos de concesión de autopistas de peaje en España y su influencia sobre los incentivos en la licitación. Universidad de Granada y Universidad Politécnica de Madrid.

Bain, R., 2009. Error and optimism bias in toll road traffic forecasts. Transportation, 36(5), 469-482.

Bel, G., Foote, J., 2009. Tolls, Terms, and Public Interest in Road Concessions Privatization: A Comparative Analysis of Recent Transaction in the USA and France. Transport Reviews 29(3), 397-413.

Bennett, J., Iossa, E., 2006. Building and Managing Facilities for Public Services. Journal of Public Economics 90(10-11), 2143-2160.

Bitsch, F., Buchner, A., Kaserer, C., 2010. Risk, Return and Cash Flow Characteristics of Infrastructure Fund Investments. EIB Papers, 15(1), 106-136.

Blanc-Brude, F., Goldsmith, H., Välilä, T., 2009. A Comparison of Construction Contract Prices for Traditionally Procured Roads and Public–Private Partnerships. Review of Industrial Organization 35(1-2), 19-40.

Carpintero, S., 2002. Las concesiones de carreteras en los países en vías de desarrollo. El caso de Argentina y de México. Revista de obras públicas, 3425, 113-118.

Chasey, A.D., Maddex, W.E., Bansal, A., 2012. Comparison of public-private partnerships and traditional procurement methods in North American highway construction. Transportation Research Record: Journal of the Transportation Research Board 2268(1), 26-32.

De Palma, A., Prunier, G., Leruth, L., 2009. Towards a principal-agent based typology of risks in public-private partnerships. International Monetary Fund, 9(177).

Delmon, J., 2009. Private Sector Investment in Infrastructure: Project Finance, PPP Projects and Risks. Kluwer Law International: Second Edition.

Engel, E., Fischer, R., Galetovic, A., 1997. Highway franchising: pitfalls and opportunities. The American Economic Review, 87(2), 68-72.

Engel, E., Fischer, R., Galetovic, A., 2001. Least-present-value-of-revenue auctions and highway franchising. Journal of Political Economy, 109(5), 993-1020.

Engel, E., Fischer, R., Galetovic, A., 2003a. Soft Budgets and Highway Franchising. 4th Annual Latin America Conference of Infrastructure and Resources, Stanford Centre for International Development and Stanford Institute for Economic Policy Research.

Engel, E., Fischer, R., Galetovic, A., 2006b. Renegotiation without holdup: Anticipating spending and infrastructure concessions. National Bureau of Economic Research.

Engel, E., Fischer, R., Galetovic, A., 2009b. Public-private partnerships: when and how. Stanford Center for International Development; Working Paper.

Engel, E., Fischer, R., Galetovic, A., 2014. The economics of public-private partnerships. A basic guide. Cambridge: Cambridge University Press.

Engel, E; Fischer, R; Galetovic, A; Hermosilla, M., 2009a. Renegociación de concesiones en Chile. Estudios Públicos, 113, 151-205.

Eurostat, 2016. Manual on Government Deficits and Debt Implementation of ESA 2010. Eurostat.

Galiani, S., Gertler, P., Schargrodsky, E., 2005. Water for life: The impact of the privatization of water supply on child mortality. Journal of political economy, 113(1), 83-120.

GAO, 1999. Public-Private Partnerships. Terms Related to Building and Facility Partnerships. United States General Accounting Office.

Grimsey, D., Lewis, M.K., 2002. Evaluating the risks of public private partnerships for infrastructure projects. International Journal of Project Management 20(2), 107-118.

Grimsey, D., Lewis, M.K., 2004. Public private partnerships: The worldwide revolution in infrastructure provision and project finance. Cheltenham: Edward Elgar.

Guasch, J., 2004. Garanting and Renegotiating Infrastructure Concessions. Doing it Right. The World Banck, Washington.

Guasch, J., Laffont, J., Straub, S., 2008. Renegotiation of concession contracts in Latin America. Evidence from the water and transport sector. International Journal of Industrial Organitzation 26(2), 421-442.

Harris, S., 2004. Public private partnerships: delivering better infrastructure services. Inter-American Development Bank, working paper.

Hart, O., 2003. Incomplete contracts and public ownership: Remarks, and an application to public private partnerships. The Economic Journal, 113(486), 69-76.

Hart, O., A. Shleifer., Vishny, R.W., 1997. The Proper Scope of Government: Theory and an Application to prisons. The Quarterly Journal of Economics 112(4), 1127-1162.

Hartz, A.J., Krakauer, H., Kuhn, E.M., Young, M., Jacobsen, S.J., Gay, G., Rim, A.A., 1989. Hospital characteristics and mortality rates. New England Journal of Medicine, 321(25), 1720-1725.

HM Treasury, 2003. PFI: meeting the investment challenge. HM Treasury.

Hodge, G.A., Greve, C., 2007. Public–Private Partnerships: An International Performance Review. Public Administration Review 67(3), 545-558.

Hodge, G.A., Greve, C; Boardman, A.E., 2010. Introduction: the PPP phenomenon and its evaluation. In: Hodge, G.A; Greve, C; Boardman, A.E. (Eds.), International Handbook of Public-Private Partnerships. Cheltenham: Edward Elgar, 3-16.

Holguín-Veras, J., Cetin, M., Xie, S., 2006. A comparative analysis of US toll policy. Transportation Research Part A 40(10), 852–871.

Iossa, E., Martimort, D., 2015. The simple microeconomics of public-private partnerships. Journal of Public Economic Theory, 17(1), 4-48.

Iossa, E., Spagnolo, G., Vellez, M., 2007. Best practices on contract design in public-private partnerships. World Bank; Working Paper.

Keeler, E.B., Rubinstein, L.V., Kahn, K.L., Draper, D., Harrison, E.R., McGinty, M.J., Rogers, W.H., Brook, R.H., 1992. Hospital characteristics and quality of care. Journal of the American Medical Association, 268(13), 1709-1714.

Kerf, M., Garay, R., Irwin, T., Levesque, C., Taylor, R., 1998. Concessions for infrastructure. A guide to their design and award. World Bank Technical paper 399.

Lilley, M., DeGiorgio, C., 2004. A private-sector perspective. Australian Accounting Review, 14(33), 34-41.

Marin, P., 2009. Public private partnerships for urban water utilities: A review of experiences in developing countries. World Bank Publications, 8.

Martimort, D., Pouyet, J., 2008. To build or not to build: Normative and positive theories of public-private partnerships. International Journal of Industrial Organization 26(2), 393-411.

Nassima, R., 2012. Water partial privatization: access and quality consequences for urban areas in Senegal. Economies and finances (dumas-00811476).

Nombela, G., De Rus, G., 2001. Auctions for infrastructure concessions with demand uncertainty and unknown costs. University of Las Palmas: Munich Personal RePEc Archive Paper.

OECD, 2008. Public-Private Partnerships: In Pursuit of Risk Sharing and Value for Money. Organization for Economic Cooperation and Development.

Phillips, R., 2008. Matrix of Risks Distribution-Roads. PPP in Infrastructure Resource Center for Contracts, Laws and Regulations. The World Bank; Washington, US.

Raisbeck, P., Duffield, C., Xu, M., 2010. Comparative performance of PPPs and traditional procurement in Australia. Construction Management and Economics, 28(4), 345-359.

Rangel, T., Vassallo, J.M., 2015. Modeling the effect of contractual incentives on road safety performance. Transport Policy 40, 17-23.

Rangel, T., Vassallo, J.M., Arenas, B., 2012. Effectiveness of safety-based incentives in Public Private Partnerships: Evidence from the case of Spain. Transportation Research Part A 46(8), 1166-1176.

Rangel, T., Vassallo, J.M., Herraiz, I., 2013. The influence of economic incentives linked to road safety indicators on accidents: The case of toll concessions in Spain. Accident Analysis and Prevention 59, 529-536.

Russo, F., Zampino, R., 2010. Machiavellian PPP? Evidence from Italian local government's projects for public services. In: International Public Procurement Conference, Seoul, South Korea, 26-28.

Shortell, S., Hughes, E.F., 1988. The effects of regulation, competition, and ownership on mortality rates among hospital inpatients", New England Journal of Medicine, 318(17), 1100-1107.

Tirole, J., 1999. Incomplete contracts: Where do we stand?. Econometrica, 67(4), 741-781.

Williamson, O., 1985. The Economic Institutions of Capitalism: firms, markets, relational contracting. The Free Press: New York.

Williamson, O., 1976. Franchise bidding for natural monopolies-in general and with respect to CATV. The Bell Journal of Economics, 7(1), 73-104.

World Bank, 2011.Public-Private Partnerships in Europe and Central Asia. The World Bank.

World Bank, 2012. Public-Private Partnerships reference guide. The World Bank.

Yescombe, E., 2007. Public-private partnerships. Principles of policy and finance. Burlington, MA, USA: Butterworth-Heinemann, Elsevier Finance.

Chapter 2

PART I: Risk Mitigation and Sharing in Motorway PPPs: A Comparative Policy Analysis of Alternative Approaches

The detailed contracts between private parties and public sector project sponsors that provide for the construction and operation of transportation infrastructure are often referred to as public–private partnerships (PPPs). Risk-mitigation and risk-sharing arrangements are critical to the long-term success or failure of transportation PPPs. This article examines the distribution of the key risks inherent in a PPP across public sector and private sector partners in road infrastructure PPPs. It draws lessons from the use of alternative risk-mitigation mechanisms across several countries, focusing on how aspects of PPP concession contracts allocate risks on both demand and cost sides of an infrastructure facility.

Keywords: comparative analysis, case studies, public-private partnerships, risk management, risk allocation, motorways.

JEL Codes: H11, H44, H54, H81, L33.

1. Introduction

Concerns about risk sharing and risk transfer are generating renewed scholarly interest in public-private partnerships, or PPPs[6]. PPPs are an important complement to traditional procurement, partly because they are based on careful analysis of the relevant risks and their distribution across the main contracting parties to the PPP (Hodge et al., 2010; Albalate, 2014). Under traditional procurement major project risks (such as demand risk) are by default completely borne by taxpayers.

A key PPP characteristic is that private partners bear risks inherent in the construction and operation of public infrastructure. The degree of risk transfer from taxpayers to private parties is linked directly to the degree of private involvement, as indicated in Asian Development Bank (ADB 2008, p. 28). The ADB distinguishes types of projects on the basis of differences in (i) the bearing of commercial risk (also called demand or market risk) and (ii) the overall level of risk (including for instance regulatory risk) assumed by the private partner (see also Hodge et al., 2010).

Many motorway PPP concessions exemplify this situation[7]. They require large, sunk, irreversible investment enabled by long-term, complex contracts. Moreover, they involve uncertainty about the evolution of demand and other key economic variables, such as construction and operating costs. Motorway concession contracts are important to study because they are utilized throughout the world but display similar institutional characteristics across specific contract types. This is especially true when compared to other sectors such as water distribution or solid waste. Because of this relative contractual homogeneity, motorway concessions are more suitable for an international comparative analysis through examination of differing regulations and contracts regarding risk mitigation and risk sharing. We examine differing approaches to risk mitigation in toll motorway concessions in countries we selected based on the availability of PPP contract data. Our sample includes tollways in South America and Europe[8]. Due to the international comparison covered below, we

[6] See contributions in PPP risk management by Grimsey and Lewis (2002) and Yescombe (2007), among others. Rachwalski and Ross (2010) provide a discussion on whether the government's PPP program should be run by a special purpose agency or by line departments.
[7] We recognize that the term concessions could be applied to either new construction (i.e. "greenfield" projects) or to leasing an existing facility (i.e. "brownfield" projects). Our analysis focuses on greenfield projects.
[8] The United States is not included because contractual data involving building tasks is scarce. More importantly, the institutional framework and regulations governing PPPs and risk

must acknowledge that experiences work under different political, governance, and cultural contexts.

2. Theoretical Framework

A potential benefit from private infrastructure investment is the ability of private investors to bear some of the risks associated with the financing, design, construction, renovation, and operation of a transportation facility. Specific risks vary with the project in question. A role of the PPP agreement is to determine how the risks inherent in a project will be distributed across the government sponsor and the private partner (Grimsey and Levis, 2002). Without some form of private participation, taxpayers bear all risks associated with financing, designing, constructing, operating, and maintaining a transportation asset. However, as Vining et al. (2005) warn, PPPs are often prone to high contracting costs, conflict, opportunism, and failure.

PPP risks have been usefully divided into two broad categories: global risks and elemental risks (Grimsey and Lewis, 2002; Lilley and DeGiorgio, 2004). These categories help guide risk allocation. Global risks include legal, environmental, and political risks, while elemental risks arise from operational, financial, and revenue-generation issues. The public partner may be better able to manage risks associated with sovereign, regulatory, environmental, and force majeure events. Private partners may be better positioned to manage operational, financial, and revenue-generation risks and spread them out over many diversified global investors. The main risks associated with a transportation project that are subject to sharing with private partners (and which will be the main focus of our country studies), include:

Demand risk (also known as traffic, commercial, or market). This may be the most important economic risk associated with the delivery of a new transportation facility. Actual traffic volume, and thus revenue, may be less than projected at the time the facility was planned and constructed[9]. That risk impacts the private partner's financial viability, and thus its ability to repay debt. In many PPP agreements, the private partner receives compensation through collection of the facility's toll revenue. Indeed, the private partner typically assumes

management is determined by state-level rather than at federal-level policy decisions (Geddes and Wagner 2013). A comparison between large countries and individual US states would seem inapposite.

[9] See Perkins (2013) for a categorization of factors influencing traffic risk in motorway projects.

demand risk. This is consistent with efficient risk allocation principles, since private investors are usually diversified, assume demand risk voluntarily, are experts in risk management, and are compensated for this type of risk bearing. That risk bearing may be moderated, however, if the contract includes government-provided revenue guarantees. Taxpayers in this case promise a minimum level of revenue, even if the traffic demand necessary to sustain that revenue is not actually realized[10].

Cost overrun risk. This is the risk that the actual cost of a transportation project exceeds its expected cost. Numerous risks associated with completing a transport facility may cause costs to rise, such as unexpected geological conditions, problems in design, and increases in cost of materials. Cost overruns are a significant risk in transportation projects in many countries, particularly under traditional procurement methods (O'Donnell, 2009).

Land expropriation risk. This is the risk that the owners of the land must be compensated at a far higher price than anticipated. This could be due, for example, to judicial decisions that increase the land compensation costs (Albalate et al., 2015). Land expropriation is one type of cost overrun risk, and is sometimes considered apart from construction cost risk.

Maintenance and operational risks. These include maintenance costs that are higher than anticipated, as well as operational failures (see Nombela and de Rus, 2004). One key type of operational risk is that road capacity might become unavailable. It includes lack of roadway availability during winter due to snow and ice, staff management issues, and accidents and construction.

Financial risk. This risk arises because anticipated project financing might not materialize at the expected cost of finance. It includes not only risks associated with raising the necessary capital, but also exchange-rate risks, interest-rate risks, and insurance costs, among other sources.

There are two basic elements to managing infrastructure risk in PPPs: which party is best able to actually control the idiosyncratic (or project-specific) risks and which is best able to bear the remaining systematic risk via hedging and diversification. Investors may be better able to manage some risks while others are best borne by the public sector. The contracting parties should determine

[10] The risk from a competing facility is a subset of traffic or revenue risk, since a competing free facility may reduce traffic and revenue on a nearby PPP facility.

the best allocation for the particular project at hand given prevailing capital market conditions. They are likely to allocate the risk to the party who is able to manage it at least cost. The optimal risk allocation across parties is thus likely to vary across projects, jurisdictions, and time. The public sponsor might assume greater risk in order to attract private investment and to realize the numerous other benefits associated with private participation. The distribution of risk sharing does in fact appear to vary widely across projects.

One of the main social functions of a PPP contract is to allocate risks across taxpayers and the private partner. Although taxpayers are rarely thought of as equity capital providers, there is now broad agreement that they are nevertheless residual risk bearers in public sector projects financed through government-issued debt (Lucas 2012, p. 40). That is, both private investors and taxpayers are the project's residual claimants, i.e. those who bear the risks of the project's variable net cash flows (Geddes, 2014).

The question of which risks are best borne by investors and which by taxpayers in their capacity as residual claimants can be best understood through careful analysis of the differing nature of the two types of residual claims. For example, investors' residual claims are typically transferable and feature limited liability. Alternatively, taxpayers' residual claims are by definition attached to the jurisdiction initiating the public project and are thus non-tradable.

The tradable nature of investors' residual claims is critical for which group is better able to bear project risk. The tradability of investors' residual claims means that investors are able to adjust their exposure to project risk by either buying or selling residual claims. Risks that private investors are better able to manage through tradable residual claims are likely to include demand risk, cost-related risks, and managerial risks. Taxpayers, on the other hand, may be better able to manage regulatory-related risks and risks associated with environ- mental regulations, for example. However, because the exact nature of those risks is likely to vary across projects, the optimal risk allocation will vary across projects and jurisdictions.

The above mechanism can be contrasted with the non-tradable nature of taxpayers' residual claims. Although taxpayers are residual claimants who bear project risk in the traditional delivery case (Lucas 2010, 2012), non-tradability means that no price for the claim can be established. Risk therefore cannot be transparently priced in the traditional case. The social cost of bearing in the

taxpayer case remains opaque, but those risks will inevitably be borne through the tax and transfer system.

The optimal risk allocation across taxpayers and investors is important in attracting private capital to an infrastructure project. Because investors have numerous options, if the expected returns on an infrastructure project do not adequately compensate investors for the risk assumed, then the project will fail to attract the necessary investment. The public project sponsor may, as a result, wish to adjust the degree of risk assumed by taxpayers relative to private investors. Risk sharing between taxpayers and private investors is thus a critical consideration.

3. Risk Mitigation and Sharing: International Experience

This section reviews PPP concession contracts signed in different countries at different times. We focus on the distribution of risks between public and private sector partners to identify salient patterns across countries and over time. We examine countries chronologically according to the first motorway PPP. Countries were selected according to the availability of original PPP contractual information.

3.1 Spain

In the late 1960s, tight fiscal constraints coupled with the capital requirements of Spain's first motorways led the Francoist dictatorship to choose concessions awarded to private investors as a model for motorway provision. Since then, the Spanish government has awarded 32 concessions to private partners for the building and operation of tolled motorways. A review of the regulatory design of those PPPs shows a clear evolution from early concessions to those awarded in the 1990s and 2000s. Based on important changes in laws regulating concessions passed in 1972, 2000 and 2003, we distinguish three different phases of evolution of PPP design: 1953–1971, 1972–1999, and 2000–2013. Table 1 shows how major PPP risks were allocated to the public sponsor, the private partner, and shared between the two, across the three periods.

During the first two phases, PPP contracts transferred demand risk from taxpayers to the private partner. The bearing of this risk led to the bankruptcy and renegotiation of some concessions in the early 1980s, most of which were

the result of contractual incompleteness, the agreements' fixed term, increases in maintenance and operational costs, and inaccurate demand forecasting (Bel, 1999). On other occasions, the government's desire to encourage added investment (or reduce tolls) contributed to a high renegotiation rate (Bel and Fageda, 2005).

In Spain, direct taxpayer-provided financial guarantees and assistance were gradually withdrawn. This was coupled with growth of indirect taxpayer subsidies and assumption of demand risk through loans granted under favorable conditions.

Cost overruns and maintenance and operation risks were borne by the private partner in all phases. However, those risks not controlled by the concessionaire were addressed through an automatic compensation mechanism during the project's construction phase. Maintenance and operation costs were addressed during the first phases through automatic toll increases linked to service costs. In the second PPP design phase, delays attributable to the government were also included with different compensation mechanisms, as shown in Table 1.

Financial risks were almost completely borne by the state through its explicit guarantee of private debt and through government-provided exchange rate insurance, which protected the private partner from exchange rate fluctuations but imposed a large burden on the public treasury (i.e. on taxpayers). The government also included financial assistance during the early concession years that in some cases were not expected to be reimbursed. However, in the third phase any financial assistance provided to concessionaires had to be paid back by investors.

Moreover, there is growing use of contractual clauses protecting private partners from government-led changes in service standards for concessioned infrastructure. Such changes must be compensated for via adjustments in concession length or through changes in the toll schedule (see Bel, 1999; Bel and Fageda, 2005; Albalate, 2014).

In sum, although Spain has a strong tradition of PPP use, it has experienced severe instability in PPP regulation. Joining the European Community in 1986 probably improved PPP regulatory and financial stability, reducing the need for government mitigation of financial risks.

Table 1. Motorway PPPs in Spain: risk distribution and state guarantees

Risk	Private	Public	Share	Guarantees/Options
			1967-1971	
Demand	X			
Cost overrun	X		X	Extension for delay of *force majeure* Toll increase due material and energy costs
Land expropriation	X			
Maintenance and operational	X		X	Toll increase due to material and energy prices
Financial		X		Debt endorsement by the State Exchange rate Insurance Asset amortization during the first five years Advances without interest when income gap from expected income
			1972-1999	
Demand	X			
Cost overrun	X			Extension for delay of *force majeure* or attributable to the State
Land expropriation	X			
Maintenance and operational	X	X		Toll increase due to service costs until 1990; updates on CPI since then
Financial			X	Debt endorsement by the State Exchange rate Insurance until 1988 Advances without interest Subsidies (not to be reimbursed) to promote a motorway before profitability hurdle rate Compensation due to changes led by governments of services and tolls; since 1996 they may include concession length extensions Subordinated loans since 1996
			2000-2013	
Demand			X	Subsidies possible Assistance when the road is used before schedule and before profitability hurdle rate Renegotiation when the profitability hurdle rate is not achieved or it surpasses the maximum profitability

Table 1. *(Continued)*

Risk	Private	Public	Share	Guarantees/Options
Cost overrun	X			Extension for delay of force majeure or attributable to the State Revision of prices subject to CPI Termination when there is an increase or a decrease by 20% of the price of the public works because of changes due to government's decisions
Land expropriation	X			
Maintenance and operational	X			
Financial	X		X	Refundable advances Subordinated and participating loans Toll and duration changes due to government modifications of services Minimum returns due to force majeure Mortgages Debt securitization Non-monetary contributions

3.2 France

France is another toll road concession pioneer. Prior to the 1970s, the concession model relied on public entities to manage motorway construction, operation, and toll collection. The French government in the 1970s began granting concessions to fully private companies. Four concessions were awarded between 1970 and 1973. However, at the beginning of the 1980s all private concessions, except those serving the densest routes to and from Paris (Cofiroute), were re- nationalized (Fayard et al., 2012). Gandil (2005) suggests that inaccurate demand forecasting, exacerbated by the two oil crises, was a main driver for re-nationalization.

The second phase of private concession awards was between 2002 and 2006. Most concessions took the form of operation and management rather than build–operate–transfer (BOT) contracts. However, some BOT contracts were also awarded during that period. One example was the 55-year A65 motorway (Autoroute Gascogne) concession granted to A'liénor in 2006. Table 2 compares the BOT contracts associated with PPPs in the 1970s to the private concessionaire Cofiroute (A10, A11) and the 2010 concession of A'liénor (A65).

The table identifies differences in the distribution of risks and guarantees offered.

The French government actively encouraged the transfer of risk to private partners through BOT projects. Government guarantees mitigated only a few financial risks (e.g. final nationalization or compensation when the concession was no longer financially viable). France provides an example of a PPP tradition offering regulatory stability with continuity between old and new contracts.

Table 2. Motorway PPPs in France: risk distribution and state guarantees

Risk	Private	Public	Share	Guarantees/Options
1970-1981 (A10-A11)				
Demand	X			Since year 20, repurchase option by the State, with compensation
Cost overrun	X			Connections to other motorways State responsibility in *force majeure* Project changes in unfinished sections if traffic is lower than expected in already opened sections or when it required debt increases
Land expropriation	X			Availability of publicly owned terrains Commitment in accelerating administrative procedures
Financial	X		X	Financial debt guaranteed up to 65% Repayable advances reimbursed by the concessionaire from year 15 During first 10 years the concessionaire could change tolls; since year 10, tolls updated by public works price index If concessionaire cannot satisfy obligations, new bidding; if no investors, then nationalization
2002-2006 (A65)				
Demand	X			
Cost overrun	X			Right of cancelation with compensation when *force majeure* delays longer than one year
Land expropriation	X			
Financial	X		X	Cancelation and compensation if financial balance is not possible Tolls firstly set by contract during first five years vary according to inflation Tolls revised each 5 years

3.3 Chile

Chile has also developed extensive experience with transportation PPPs over the last two decades. Its approach to facilitating collaboration between the public and private sectors has become a global model for PPP design. Chile has been awarded 37 motorway PPP concession projects since 1993.

We identify two main phases in Chilean PPP evolution. The first included 15 PPP awards granted from 1993 to 1998. All except the Santiago–Valparaíso motorway were renegotiated by the end of that decade. Engel et al. (2009a) explain that almost all agreements bilaterally negotiated between the government and the concessionaires were initiated by the government, and were due to changes in the contract (i.e. change orders) and to new work not included in the original contract. In contrast, almost all renegotiations that were subject to conciliation and arbitration were initiated by the concessionaire. They were driven by cost overruns and sanctions imposed by the regulator on the concessionaire.

Those renegotiations marked a new era in Chilean PPP design. They resulted in the development of a new, variable-term concession approach, called a least present value of revenue (LPVR) auction (Engel et al., 1997, 2001). The LPVR auction is designed to mitigate the effects of concessionaire demand risk. LPVR auctions became the standard method for awarding PPP concessions in Chile within the framework of the 2010 public works law. Indeed, the first concessions that only included the minimum revenue guarantee were renegotiated when Chile experienced a macroeconomic down- turn in the late 1990s. Those renegotiations provided the impetus for adopting LVPR auctions, which is an innovative and unusual system of variable term contracts.

Cost overrun risks were always borne by the private sector, although compensation is made for government-induced changes or delays. Unlike the Spanish case, land expropriation risk is fully covered by Chilean government if we consider that it facilitated the availability of land and compensated the concessionaire for any gap between the agreed cost and the final cost. On the other hand, government assumption of PPP financial risk is prominent in Chile in the second phase, as described in Table 3.

Added guarantees such as exchange rate insurance and state bonds that help address financial risks were introduced in the second phase. Together with mechanisms for the mitigation of demand risk, this may be the most important difference between the two phases in Chile.

In sum, the Chilean experience is compelling because well-functioning institutions and effective PPP regulatory design were successful in attracting international private capital to infrastructure projects. The government effectively addressed exogenous risks in Chile in the second phase after widespread renegotiations at the end of the 1990s. Risks addressed include compensation because of land expropriations, financial costs related to exchange rates, or changes in the conditions of service promoted by the government, and in the case of demand risk. Chile is thus a pioneer in the use of variable-term mechanisms for demand-risk mitigation that are designed to ameliorate one of the basic causes of high concession renegotiation rates. This mechanism's ongoing use is testimony to its success. It is now the standard PPP-awarding mechanism in Chile.

Table 3. Motorway PPPs in Chile: risk distribution and state guarantees

Risk	Private	Public	Share	Guarantees/Options
			1993-2000	
Demand			X	Minimum income guarantee
Cost overrun	X			Geological risk Extension for delays not attributable to concessionaire Modifications of terms in government-led changes
Land expropriation		X		Land availability Monetary compensation for differences between agreed and real costs
Financial	X			Complementary contract for infrastructure expansion that changes the economic-financial situation of the concessionaire Maximum investment to protect concessionaires from government demands Subsidies in low demand and costly projects
			2000-2013	
Demand			X	Maximum duration of the concession Internalization of demand risk by variable term mechanism Least present value of revenues awards since 2008
Cost overrun	X			Geological risk Extension for delays not attributable to concessionaire Modifications of terms in government-led changes

Table 3. *(Continued)*

Risk	Private	Public	Share	Guarantees/Options
Land expropriation		X		Land availability Monetary compensation for differences between agreed and real costs
Financial			X	Complementary contract for infrastructure expansion that changes the economic-financial situation Maximum investment to protect concessionaires from government demands Subsidies in low demand and costly projects Exchange rate insurance Compensations due to changes attributable to the state since 2010

3.4 Brazil

There are currently 15 privately managed transportation concessions operating under federal government authority in Brazil, and another 41 concessionaires operating in nine states. There were three distinct phases in motorway concessions operating under federal authority, with two distinct contract types. Six concessions were granted in the first phase between 1994 and 1997. In 2001, the National Surface Transportation Agency (ANTT) was created as the institution responsible for granting federal transportation concessions. A new public-private partnership law came into effect in 2004. A second series of concessions was awarded on eight federal highways between 2007 and 2009. The concession contracts were the same as those awarded in the 1990s during the first phase. However, the BR-116/324/BA concession used a different contract type. It marked the beginning of a different contractual approach (Amorelli, 2009; Graeff, 2011), which was used again in the 2013 BR-101/ES/BA concession. This second contract type is important because it was the first to clearly define those risks borne by government versus by the private partner. Table 4 compares both contract types.

Brazil has been very active in awarding motorway concessions over the past decade. Indeed, it offers a large and developed infrastructure market, with most risks transferred to the private partner. Because contracts do not contain specific demand-risk mitigation clauses, private partners bear that risk by default. The same is true of cost overrun, land expropriation, exchange rate, and capital risks. Extensions not included in the initial project are reimbursed according to a

predetermined rate of return. Brazil, however, clarified risk distribution in more recent contracts relative to previous practice. This suggests improved cooperation between the private and public sectors in an uncertain business such as motorway construction, operation and, management. The distribution of risk has remained stable despite such clarification, perhaps because Brazil has not experienced a significant wave of renegotiations and previous PPP failures.

Table 4. Motorway PPPs in Brazil: risk distribution and state guarantees

Risk	Private	Public	Share	Guarantees/Options
1994-2009 (Standard Contracts)				
Demand	X			
Cost overrun	X			Tolls revised if unilateral changes in works produced by government's decisions Compensation given *force majeure*
Land expropriation	X	X		Tolls revised if expropriation costs exceed standards
Financial	X		X	Guarantee of economic-financial balance given changes in taxes, force majeure, and other sources of revenues Structural adjustments in relative prices when production factors are not covered by toll adjustments
2009-2013 (New Contracts)				
Demand	X			
Cost overrun	X			Guarantee of economic-financial balance if unilateral changes in works produced by the government; also when social strikes affect construction Compensation for extensions not included in the awarded project according a given IRR
Land expropriation	X			
Financial			X	Guarantee of economic-financial balance given changes in taxes, *force majeure*, competing investments, breaking of agreements by the state, government's decisions preventing toll collection, social strikes affecting service delivery Tolls vary according to inflation of productive factors and CPI

3.5 Poland

Poland's legal and regulatory institutions originate from a very different economic tradition, being heavily influenced by communism from at least 1947 until the Soviet collapse in 1989. After the collapse, the government focused on the need to improve and develop the country's road infrastructure. The first Polish PPPs were concluded in the 1990s to finance, develop, and operate the A1 and A2 motorways. However, contracts with concessionaires could not be completed (due to an inadequate legal framework) until the second half of that decade. The A1 motorway contract was renegotiated in 1997 to allow modification of applicable financing regulations. The main reasons for that renego- tiation were lack of agreement on the price to be charged and the concessionaire's financial difficulties under the standard BOT contracting scheme (Bak and Burnewicz, 2005). The 2003 amendments to the Act on Toll Motorways guaranteed legal security to financial institutions when financing road projects.

The A1 project was divided into two distinct phases. Contractual agreement for the first stage of the 90 kilometer, 34-year concession was reached in 2004. Financial agreement occurred in 2005. Cost overrun risks were transferred to private partners, but demand risk was shared via compensation from taxpayers when actual traffic was lower than expected.

The A2 concession was awarded in 1996 for 40 years, but was amended in 2000. Heavy vehicle tolls, which were viewed as too high and causing traffic diversion onto secondary roads, were removed. The concessionaire received substantial compensation for lost revenue. In this case, cost overrun risks are borne by the concessionaire, while demand and financial risks are shared. Table 5 displays information on the distribution of risks in these concession contracts.

Poland's experience suggests that financing challenges along with weak legal protections inhibits private participation through PPPs. Legislative changes may lead to long delays in private participation. Financial mechanism reform, including moder- nization of the fiscal system and changes in demand risk allocation, allowed Polish PPPs to flourish. The main difference between the A2 and A1 concessions is the allocation of demand risk; only the A2 included profit sharing. Financial risks were fully transferred to the private partner in the A1 motorway concession. On the A2, the government bears risk through its portion of the loans provided by the European Investment Bank.

Table 5. Motorway PPPs in Poland: risk distribution and state guarantees

Risk	Private	Public	Share	Guarantees/Options
1997-2000 (A2)				
Demand	X		X	Revenue sharing according to internal rate of return for excess profits
Cost overrun	X			
Land expropriation		X		Land provided by the State, concessionaire pays rent
Financial	X		X	State bears with part of EIB loans
				Monetary compensation linked to net present value and debt payment in case of project cancellation by government decision Non-competing investments commitment or compensation Compensation for heavy vehicle traffic since 2005
1997-2004 (A1)				
Demand			X	Monetary compensations when real traffic is lower than expected
Cost overrun	X			Compensation for government-led changes
				Delay attributable to the State
Land expropriation	X			
Financial	X			Shadow toll payments charged to the National Road Fund Monetary compensation for project cancellation by government decision

3.6 Argentina

By 2003, the experience in Argentina with motorway PPP awards was influenced by prior road privatization policy and associated failures from the 1990s and early 2000s. Privatization was particularly active between 1990 and 1994. It affected existing conventional roads rather than motorways (with the exception of three motorway accesses to Buenos Aires), which is outside the scope of our study. However, Argentina offers a unique lens through which to view motorway PPP concessions due to the widespread renegotiations and civil protests with which they are associated.

We examine Argentina's past experience with private participation in the conventional road sector. That period was marked by a period of macroeconomic instability and hyperinflation, as well as by social discontent provoked by toll increases before the promised investments were completed. Those combined factors resulted in waves of contract renegotiation. The renegotiations in turn resulted in reforms that changed the indexation of contracts and the canon/subsidy system (Estache and Carbajo, 1996). However, certain renegotiations were also driven by a desire to improve and expand some routes, and to reduce the need for subsidies (Serafinoff, 2008).

By 2003, that experience had influenced PPP motorway concession award design. Concessions were focused on the rehabilitation and extension of existing motorways, which included the introduction of standard BOT PPPs. In contrast to the 1990s, demand risk was shared through an established renegotiation mechanism that varied tolls to allow the concessionaire to break even, as shown in Table 6. This reduced concession instability by facilitating more reliable toll revenue, in contrast to past experience. In fact, maintenance and operational cost risks were borne by the state, given that toll increases were mitigated by a clause that protects users in case of large traffic volumes. Contracts also created a shared distribution of cost overrun risks, with recognition of labor cost deviations. Financial risks were the only risks transferred to the private sector without any state assistance.

Table 6. Motorway PPPs in Argentina: Risk distribution and State guarantees

Risk	Private	Public	Share	Guarantees/Options
2003 (New Awards)				
Demand	X		X	Renegotiations are recognized as a mechanism to vary tolls to guarantee concessionaire breaks even
Cost overrun	X		X	Renegotiation of tolls when construction costs and labor costs deviate
Maintenance and operational		X		Tolls determined by maintenance costs
Financial	X			State subsidy only exceptional

4. Discussion

Our review of alternative country experiences with PPP concession contracts allows us to distill key elements that have shaped private participation in motorway concessions over time. We focus on the distribution of various risks across the public and private sectors. The first is the relationship between risk mitigation/risk sharing and attracting private capital. The second focus is on factors most likely to reduce the probability of renegotiations.

4.1 Risk Mitigation and Private Capital Attraction

On the first point, we identified similar patterns across countries when regulatory risks and financial and macroeconomic instability are concerns for private sector investors. Table 7 provides a structured comparison between macroeconomic and institutional stability and PPP design. We also consider whether the country had past experiences in motorway PPP awards. Countries with higher institutional quality and stability are able to engage in PPPs with fewer guarantees or less need for sharing the risks associated with demand, cost overrun, and maintenance and operation. Past failures might offset this stability however. Those countries may provide guarantees or risk-sharing mechanisms to mitigate the effect of past experiences. We also find a similar pattern in countries that require access to global capital markets as well as global motorway operating companies, instead of relying on domestic investors and managers only.

Spain is a good example of this first point. In the late 1960s and early 1970s, Spain required stronger financial guarantees in order to facilitate private participation in PPPs given its greater political, financial, and institutional risks. This became less important after Spain entered the European Community, which offered a more stable institutional setting. The degree of taxpayer risk bearing declined due to enhanced institutional, regulatory, and financial stability. However, past experience shows that failures were possible and some sharing mechanisms were included in the most recent awards regarding demand and financial risks.

In contrast, France has a long tradition of national PPPs with stable governance mechanisms, regulation, and institutional frameworks. This allowed France to attract private risk capital with weak taxpayer guarantees. France

enjoyed macroeconomic and institutional stability over time, and so did its PPP designs.

Table 7. Institutional and macroeconomic stability and PPP designs

Macroeconomic context	Institutional context	Past experience	PPP design
Spain 1967-1971			
Foreign capital needed Economic growth due to economic reforms	Political stability	First experience	Cost overrun and maintenance and operational risks shared Financial risk borne by state
Spain 1972-1975			
Foreign capital needed Economic crisis.	Political instability	Success to date	Financial risk sharing Maintenance and operational risk borne by state
Spain 1996-1999			
Domestic capital available Economic growth Inflation and interest rate decrease	EU membership and leading to Monetary Union	Successes and failures	Financial risk sharing Maintenance and operational risk borne by state
Spain 2000-2013			
Domestic capital available Rapid economic growth Low interest rates Higher inflation than average EU	EU membership and Monetary Union	Successes and failures	Sharing of demand and financial risks
France 1970-1971			
Domestic capital available	European Community membership	First experience	Only guarantees in case of financial risk
France 2002-2006			
Domestic capital available	EU membership and Monetary Union	Successes and failures	Only guarantees in case of financial risk

Table 7. *(Continued)*

Macroeconomic context	Institutional context	Past experience	PPP design
Chile 1993-2000			
Foreign capital needed Low inflation and interest rates Fiscal accounts balanced Economic growth High capital inflows	Gradual reforms after transition to democracy	First experience	State bears land expropriation risk and risk sharing is available for demand risk
Chile 2000-2013			
Foreign capital needed Decreasing inflation rate Fiscal accounts balanced	Political stability	Generalized renegotiations	Risk sharing available for financial and demand risks Land expropriation risk still borne by the state
Brazil 1994-2009			
Foreign capital needed Currency crises and devaluations High capital flows volatility High inflation and interest rates Slow economic growth	Political stability	First experience	State bears with land expropriation risk Risk sharing available for financial risk
Brazil 2009-2013			
Foreign capital needed Economic growth	Political stability	Success	Risk sharing available for financial risk only
Poland 1997-2000			
Foreign capital needed Economic growth High inflation rate Low debt to GDP	Political reforms after transition from communist regime	First experience with prior legal problems to attract private capital	Risk sharing available for financial and demand risks Land expropriation risk borne by the State

Table 7. *(Continued)*

Macroeconomic context	Institutional context	Past experience	PPP design
	Poland 1997-2004		
Foreign capital needed Economic growth High inflation rate Low debt to GDP	Leading to EU membership	First experience with prior legal problems to attract private capital	Risk sharing available for demand risks only
	Argentina 2003		
Foreign capital needed Recession Currency crises and devaluations Large deficits and debt to GDP Two-digit inflation (2002) High capital flows, volatility	Three presidents since 2001	Failures	Cost overrun and Demand risks are shared Maintenance and operational risk is borne by the state

We find the opposite in some Latin American countries, where political, regulatory, and financial instability, together with the need to attract international capital and industrial partners, resulted in greater protection through government guarantees and risk sharing. This is clearly seen in the cases of financial and demand risks. This occurred in Argentina and Brazil (also in the first phase of PPPs in Spain, before accession to the European Union (EU), when that country was in need of foreign capital to support the necessary investment). Indeed, the background of past instability and poor institutional quality influenced PPP awards in Argentina in 2003, which had to include clear risk-sharing guarantees on key aspects of the motorway business.

Chile is slightly different. Equipped with a better institutional reputation, Chile was able to test regulatory innovations, such as the LPVR auction, before they were more widely accepted as a valuable PPP tool. We confirmed our view through examination of recent PPP contracts in Poland, which, after difficulties

in the 1990s, offered a more predictable and stable institutional scenario for private participation once the country had prepared to be member of the EU.

A first important policy implication emerges regarding risk management and attraction of private capital: It is important to consider the differing characteristics of risk bearing between taxpayers and private investors when structuring PPPs to attract private capital. For example, risks that can be diversified away using tradable residual claims, such as common stock and other tradable financial instruments, are likely to be more acceptable to private investors than are risks that cannot easily be borne in this manner, such as regulatory and environmental permitting risks.

4.2 The Likelihood of Renegotiations

Motorways have very special infrastructure characteristics. When a concession fails to establish an appropriate balance of risk assumption and risk sharing, renegotiations are likely to increase. Because renegotiation (even if unavoidable in a world of incomplete contracts) usually takes place in a more opaque way, practices that reduce the likelihood of renegotiation should be considered.

PPP motorway concession contracts are inherently incomplete. An effective institutional and contractual framework must address this challenge. In particular, any project framework should dedicate attention to management and allocation of risk to avoid renegotiations. Risks should be allocated optimally to the party best able to manage the source of that risk or to the party that can bear the risk at a lower cost. For instance, there is a consensus that construction risks should be transferred to the private partner. However, as we have seen, there are particular clauses that protect the private sector from regulatory risk affecting construction and from force majeure risks. The allocation of other risks may be idiosyncratic, depending on the parties to the concession. As an illustration, land expropriation risks may be best managed by public authorities or private partners depending on the governing legal framework.

Variation in traffic is a crucial risk that must be managed. However, there is often little concessionaires can do to control it. Thus, transferring the entire risk to the private sector might discourage private investor participation and limit PPP use. We suggest PPP designs that provide risk-sharing mechanisms which avoid sudden, generalized, and opaque renegotiations after periods of

intense PPP awards, as happened in Spain after the two periods of intense concessional activity, or in France in the early 1970s. Moreover, this should allow for further spreading of PPP models, especially in risk-averse contexts.

Variable-term contracts offer an appealing solution to the sharing of demand risk and reduce the likelihood of renegotiations. The LPVR, a concession-award method used in Chile, internalizes demand risk via adjustments in contract length. Higher-than-expected demand (revenue) reduces actual concession length, while lower-than-expected demand (revenue) increases length. Thanks to such automatic adjustment there is no need for renegotiation. Demand risks due to inaccurate traffic forecasting or toll changes are no longer drivers of renegotiations. Renegotiations are less likely because the concessionaire's breakeven point does not depend on tolls, or on regulatory risk regarding toll updating policy. Moreover, it provides transparency on the concessionaire's financial situation as well as the period left to achieve the present value of revenues awarded. These advantages are realized through greater government accountability in its PPP policy. Transaction costs are also lowered through this method. Tolls are allowed to vary in response to traffic demand, which may be useful in reducing congestion in large urban areas.

The likelihood and frequency of renegotiations can also be lowered by other means and best practices. Cultural and institutional features also play a crucial role in contract design. They may also limit the applicability of a relatively small, simple set of best practices. A specific case-by-case analysis is necessary to pick an appropriate PPP design. Nevertheless, beyond risk mitigation mechanisms and optimal risk allocation, there are additional recommendations generated by this review.

First, institutional quality is key. It affects not only contractual design but also its success or failure. It is critical to establish an independent special purpose regulatory agency or unit outside the Ministry of Transportation. This is likely to be particularly important for countries with poor institutional quality where regulatory risk discourages private capital. Offering a stable, professional, and rigorous body to manage PPP policies may help attract the interest of international investors in developing countries with institutional weaknesses.

Second, because involving private partners is often driven by fiscal concerns, it is important to assess value for money, comparing the PPP project with the public sector comparator. This evaluation stage is critical for large network development programs based on PPP structures. Early road projects

may be socially profitable and financially sustainable, but extensions or later proposed projects may decrease social returns to levels where projects are no longer economical. PPPs linked to such projects may fail. Risk sharing and guarantees in those situations promote private participation but may become double-edged swords for governments wishing to increase the number of projects. PPP processes are associated with large regulatory efforts and costs that must be offset by more efficient construction and operation, which must in turn generate value for money (Albalate, 2014).

Finally, PPP structures generate sound incentives which must be appropriately studied to anticipate design effects. Guarantees designed to protect investments, such as exchange rate guarantees, may also produce perverse incentives that increase project costs and taxpayers' risk exposure. If that is the case, instead of avoiding pressures from a given risk, such guarantees may lead to renegotiations and public discontent.

5. Conclusion

Transport infrastructure PPPs remain complex, but of growing importance. This article reviews several international examples showing the success and failure of alternative motorway PPP designs. It demonstrates that a PPP policy has to be considered with caution and should be taken seriously (particularly its contractual design), in order to avoid widespread renegotiations, public discontent, and excessive costs for taxpayers. The countries chosen include a diverse array of cultural and institutional arrangements, which facilitates analysis of the sources and drivers of the success or failure of PPP design. In this vein, we examine risk management and its allocation, studying how it contributed to PPP policy outcomes in each case. PPP structures generate clear incentives to different parties. The likelihood and frequency of costly and opaque renegotiations is crucially affected by incentive-based risk transfers and risk sharing, by institutional quality as a determinant of regulatory risk, and by appropriate ex ante evaluation of PPP projects under proposed contract designs.

We offer recommendations and lessons to diminish the likelihood of costly, opaque renegotiations in the motorway industry when considering a PPP. We highlight the roles of risk-mitigation mechanisms and the importance of institutional quality and stability as factors influencing PPP design and success. This is especially important for countries that need to attract foreign capital. The

experiences reviewed illustrate the causes and effects of alternative PPP frameworks for the case of the international motorway industry.

References

ADB, 2008. Public-private Partnerships Handbook. Manila: Asian Development Bank.

Albalate, D., 2014. The Privatisation and Nationalisation of European Roads: Success and failure in Public Private Partnerships. Cheltenham: Edward Elgar.

Albalate, D., Bel, G., Bel-Piñana, P., 2015. Tropezando dos veces con la misma piedra: Quiebra de autopistas de peaje y costes para contribuyentes y usuario. Revista de Economía Aplicada, 23 (67), 131-152.

Amorelli Amorelli, L., 2009. Brazilian Federal Road Concessions: New Challenges to the Regulatory Framework. Washington DC: The George Washington University-Minerva Program.

Bak, M., Burnewicz, J., 2005. Financing Motorways in Poland. Research in Transportation Economics, 15, 145-155.

Bel, G., 1999. Financiación de infraestructuras viarias: La economía política de los peajes. Papeles De Economía Española, 82, 123-139.

Bel, G., Fageda, X., 2005. Is a mixed funding model for the highway network sustainable over time? The Spanish case. Research in Transportation Economics, 15, 187-203.

Engel, E., Fischer, R., Galetovic, A., 2001, Least-present-value-of-revenue auctions and highway franchising. Journal of Political Economy, 109(5), 993-1020.

Engel, E., Fischer, R., Galetovic, A., 1997. Highway franchising: pitfalls and opportunities. The American Economic Review, 87(2), 68-72.

Engel, E., Fischer, R., Galetovic, A., Hermosilla, M., 2009a. Renegociación de concesiones en Chile. Estudios Públicos, 113, 151-205.

Estache, A., Carbajo, J., 1996. Designing Toll Road Concessions- Lessons from Argentina. Public Policy for the Private Sector Viewpoints. Washington DC: The World Bank Group.

Fayard, A., Meunier, D., Quinet, E., 2012. Motorway provision and management in France: Analyses and policy issues. Networks and Spatial Economics, 12(2), 299-319.

Gandil, P., 2005. Development of the motorway infrastructure in France: Background and recent developments. P3 2006: The 13th Annual Conference on Public-Private Partnerships, Toronto.

Geddes, R.R., 2014. Competition issues and private infrastructure investment through public-private partner- ships. In: Cheng, T. K., Lianos, I., Sokol, D., (Eds), Competition and the State. Palo Alto, CA: Stanford University Press.

Graeff, F., 2011. Uma análise da alocação de riscos nos contratos para prestação de serviços públicos: o caso do transporte rodoviário interestadual de passageiros por ônibus. Brazilia: Tribunal de Contas da União.

Grimsey, D., Lewis, M.K., 2002. Evaluating the risks of public private partnerships for infrastructure projects. International Journal of Project Management 20(2), 107-118.

Hodge, G.A., Greve, C; Boardman, A.E., 2010. Introduction: the PPP phenomenon and its evaluation. In: Hodge, G.A., Greve, C., Boardman, A.E. (Eds.), International Handbook of Public-Private Partnerships. Cheltenham: Edward Elgar, 3-16.

Lilley, M., DeGiorgio, C., 2004. A private-sector perspective. Australian Accounting Review, 14(33), 34-41.

Lucas, D., 2010. Measuring and Managing Federal Financial Risk. Chicago: University of Chicago Press.

Lucas, D., 2012. Valuation of government policies and projects. Annual Review of Financial Economics, 4(1), 39-58.

Nombela, G., De Rus, G., 2004. Flexible-term contracts for road franchising. Transportation Research A, 38(3), 163-247.

O'Donnell, P., 2009. Establishing Measurable and Reportable KPIs. Chatswood NSW: Leighton Contractors.

Perkins, S., 2013. Better Regulation of Public-Private Partnerships for Transport Infrastructure: Summary and Conclusions. Discussion paper International Transport Forum. Paris, France: OECD.

Rachwalski, M.D., Ross, T.W., 2010. Running a government's P3 program: Special purpose agency or line departments?. Journal of Comparative Policy Analysis, 12(3), 275-298.

Geddes, R.R., Wagner, B.L., 2013. Why do U.S. states adopt public-private partnership enabling legislation?. Journal of Urban Economics, 78, 30-41.

Serafinoff, V., 2008. Transformaciones en el rol del Estado. La concesión de redes viales en Argentina. Estado, Gobierno, Gestión Pública. Revista Chilena de Administración Pública, 11, 5-38.

Vining, A.R., Boardman, A.E., Poschmann, F., 2005. Public-private partnerships in the US and Canada: There are no free lunches. Journal of Comparative Policy Analysis, 7(3), 199-220.

Yescombe, E., 2007. Public-private partnerships. Principles of policy and finance. Burlington, MA, USA: Butterworth-Heinemann, Elsevier Finance.

Chapter 2

PART II: Stumbling Twice on the Same Stone: Bankruptcy of Toll Motorways and Costs for Taxpayers and Users

This paper analyzes how risks are distributed in contracts for public-private partnership in Spanish toll motorways and what guarantees are granted over time. Although we observe that the knowledge acquired has allowed a better identification and allocation of some risks –technological progress and demand– and changes in the allocation of state guarantees against financial risk, there are still many factors that make the future of the industry gloomy. The general decline of traffic on all toll motorways –because of the economic crisis–, the construction or improvement of alternative free roads, and the expensive expropriation processes faced by some concessionaires, have produced significant losses in the most recent concessions, which have been supported partially with public funds. The ongoing debate about the solution to the crisis in the sector includes its likely nationalization.

Keywords: concessions, risks, state guarantees, infrastructures, privatization.

JEL Codes: H11, H44, H54, H81, L33.

1. Introduction

Public investment projects with negative social returns, or white elephants (Robinson and Torvik, 2005), are a general problem, with particularly important effects on transport infrastructure. The economic literature has recommended the use of public-private partnerships (PPPs) with pay-per-user to avoid them (i. e. Engel et al., 2014). But the Spanish toll motorways offer us an interesting paradox: Spain has simultaneously been a leader both in the use of PPPs for new toll motorway projects and in the execution of white elephants through these projects,[11] which have resulted in financial bankruptcy.

The recent bankruptcy of toll motorway concessions and the discussion over their rescue process has led to the re-emergence of the debate on the design of concessions to private companies, particularly in terms of risk sharing among investors, users and taxpayers. Since the late 1990s, the state has awarded 16 new concessions to 14 private companies for the construction and operation of 793 new kilometers of toll motorways. Currently, most of these concessionary companies are in insolvency proceedings due to economic-financial imbalance produced by a combination of different factors.

The history of motorway concessions in Spain shows that this is not an exceptional but rather a recurring problem in road infrastructure policy. The model of private concessions for the development of motorways in Spain has a long experience and tradition in the international context. Concession bankruptcies and subsequent bailouts have occurred since the beginning of the implementation of the concession model, as documented and analyzed by Gómez-Ibáñez and Meyer (1993), Puncel (1996), Bel (1999), Baeza and Vassallo (2008b), Prior and Puelles (2012) and Albalate (2014).

The convulsive concession processes have led to continuous changes in the regulatory frameworks for these activities, but have not so far been systematically analyzed in relation to risk sharing between the public and private sectors. Spain's pioneering character, together with constant regulatory changes, means that at present there is ample information available on risk sharing and guarantee mechanisms between the state and the private sector. A first

[11] In fact, Spanish leadership in the context of the EU regarding the mis-match between (over) supply and (deficit) demand has occurred in all modes of intercity transportation in recent decades (Albalate et al., 2015).

contribution of this work is therefore to analyze the evolution of such regulatory frameworks which apportion risks and establish guarantees.

The study of the evolution of regulatory frameworks helps to make clear the central problem analyzed in this paper, the recurrence of bankruptcies. The second contribution is the analysis of the process of bankruptcy and bailout of the most recent concession motorways in the context of the applicable regulatory framework. In fact, the recent bailouts for the nine state toll motorway concessions bear some similarities to the National Highway Company (Empresa Nacional de Autopistas, or ENA) case in the early 1980s, as both cases are the result of a major financial crisis and very significant traffic diversions. However, these two bailouts occur within different regulatory frameworks, resulting from significant reforms and advances. Our review of the evolution of the regulatory framework for motorway concessions demonstrates that despite these efforts to improve, a new financial crisis has not been avoided.

In this paper we argue that there are elements related to the objectives of infrastructure policy that can explain why regulatory improvement has not prevented the current concession crisis. Among others, one of the instruments making the pursuit of these objectives possible is the role of the guarantee, often referred to as the State's Asset Responsibility (Responsibilidad Patrimonial del Estado, or RPA). This is compensation for the early termination of the concession. With the RPA, the administration undertakes to pay the concessionaire the amount - discounted from depreciation - of (1) the investments made for the expropriation of land and (2) the execution of construction work and the acquisition of other assets necessary for the operation of the work. These amounts associated with the construction work are pledged in the financial contracts and serve as a guarantee or public insurance for the lenders. The administration's liability for assets prevents the public sector from acquiring, free of charge, the assets necessary to operate the motorway, while at the same time, it saves itself the cost of expropriation. However, this means that taxpayers directly cover the financing risk. Given the state guarantee provided by the RPA, private investors are encouraged to undertake investments with uncertain returns which they would be much more reluctant to undertake in the absence of the RPA.

Our analysis offers lessons on public policy for improving institutional and contractual design in public-private partnerships for the development of high-capacity road infrastructure. Only by understanding the reasons why the toll

motorway industry has stumbled on the same stone twice - even in the face of significant changes in its regulatory framework - can we avoid a third episode of crises and bailouts that divert this public-private partnership from the desired efficiency and equity. This is why this article recommends, among other possible reforms, the abolition of the State's Asset Responsibility (RPA).

This article is structured as follows. Firstly, it defines public-private partnerships and discusses the determining role risk sharing plays in the potential benefits of such partnerships. Next, a brief analysis is given of the evolution of the regulatory framework for motorway concessions in Spain, paying special attention to the distribution of risks and the granting of public guarantees. In this conceptual and analytical framework of risk distribution, an analysis is made of the current crisis in the sector, its parallels with the crisis of the early 1980s and the different ways of reaching a definitive solution. Finally, the article concludes with recommendations on the design of concessions.

2. PPPs and Optimal Distribution of Risk

The literature on public policy considers PPPs as contractual frameworks that promote the role of the private sector in the field of infrastructure and involve the transfer of risk from the public sector to the private partner. Risk sharing between government and private partners is a central issue in PPPs (Engel et al., 2009b, 2014). PPPs range from simple management contracts to complex design-build-financing-management contracts. Infrastructures have a long-term useful life and different tasks that can be developed by the public or private sector. The allocation of these tasks between the public and private sectors - through a single contract - determines the PPP modality.

What is essential under this PPP approach is that the contract bundles different tasks, and that there is transfer of risk to the private sector. With task bundling, efficiency gains can be achieved, since incentives are introduced to take advantage of the complementarities between tasks, which is not the case with traditional procurement. In this way, the private partner has incentives to incorporate in its objective function the whole set of tasks assigned by contract, and not to treat them individually. Bundling occurs only if a single company or several companies organized as a consortium contract and operate as a single unit - under a single contract - but not if they operate independently under different contracts with the public sector (Bennet and Iossa, 2006). With the

transfer of risk, incentives are shifted to the private partner to align its pursuit of profits with improvements in efficiency.

The industrial organization literature takes a more restrictive approach, requiring that bundling involve both construction and operational tasks (Martimort and Puyet, 2008; Engel et al., 2014). This excludes bundling that only includes operation tasks (e.g. operation and maintenance) or construction tasks (e.g. design and construction) separately. In this approach, PPPs result in longer-term contracts, which emerge as the third distinctive feature of PPPs, along with risk sharing and task bundling (Iossa and Martimort,2015).

Our analysis focuses mainly on the specific area of risk allocation and the establishment of guarantees. Contract theory states as a general rule that risk should be allocated (1) either to the party with the greatest relative control over the risk factor; (2) or to the party most able to bear the risks in cases of high risk aversion scenarios (Engel et al., 2014). Optimal distribution in PPPs requires consideration of the incentives created by the contractual relationship, as well as the risks incurred - and their coverage - by the parties. To some extent, risks and incentives are grouped into a PPP according to the standard principal-agent theory. The monitoring of these criteria should ensure a lower risk premium and thus a lower cost of capital, which will make it easier for the efficiency gains of PPPs to offset and overcome the extra cost of private funding (Engel et al., 2014).[12]

Private companies have more incentives to prevent any risk from affecting their economic and financial balance, so it is appropriate to transfer risks they can control to them, and to design contracts in such a way that those risks cannot be transferred back to the public sector. In this way, companies have incentives to dedicate their efforts to risk control in order to minimize negative impacts on expected profitability. If the company has sufficient instruments and incentives to eliminate or reduce uncertainty, then the optimal strategy to improve the functioning of PPPs involves the transfer of risk to the private sector.

In some circumstances the private sector does not have sufficient instruments to manage the variables that underlie the uncertainty and expectations of profitability, which can lead to the failure of the project. The

[12] There is consensus on the superiority of public financing of infrastructures (World Bank, 2012), given the greater capacity of governments to diversify risks and maintain greater expectations of solvency.

literature on contracting specifies that in these cases the government should assume a role in protecting against these risks, given its greater capacity to diversify them. To this end, it may grant guarantees to cover all or part of the risk. Consequently, optimal risk sharing requires achieving the best combination of incentives and risk protection: providing incentives in areas controlled by the private sector and providing protection in the remaining areas.

Table 1 briefly defines the different types of risk that must be assigned to infrastructure projects under a public-private partnership scheme. Among them are the risks of construction, expropriation, maintenance, demand, financial risks, force majeure and technological progress. The optimal allocation for each of these risks is discussed below.

Table 1. Risks in toll motorway PPP concessions

Risk	Content
Construction risk	Changes in the expected costs of the inputs, modification of the project and inauguration delays
Expropriation risk	Delay in obtaining permits and price increases in the acquisition of land
Maintenance risk	Changes in expected maintenance costs
Traffic demand risk	Errors of traffic prediction and underuse of the road by construction of a new parallel freeway
Financial risk	Increase in the exchange rate, inflation or inappropriate management of debt
Force majeure risk	Completely unpredictable events, such as natural catastrophes and wars
Technological progress risk	Update of technology according to current regulations

There is a certain consensus that construction risks should be transferred to the private sector, as private companies are better able to control the construction process and limit any cost deviation. Many studies have shown that construction under PPPs can be faster and more reliable, and have lower cost overruns (i.e. NAO, 2003; World Bank, 2012).[13] However, several components of construction risk are also allocated to the public sector. This means that,

[13] It should be noted that the update of the NAO study (2003) published in NAO (2009) no longer shows a significant difference between PPP construction and traditional contracting.

although the private sector is generally better positioned to manage construction risks, public sector collaboration is still needed to control certain risk components, such as permits, changes in standards required by the overseeing authority, strikes or public acts in opposition to the project, etc.

With regard to the risks of expropriation, and although the administration is responsible for managing the purchase of the land, the private partner bears the costs. In some cases there may be a deviation of costs from the official budget estimate that is unpredictable at the time of award and over which the private sector has no control. In such a scenario, it is the public sector that should bear the risk and its consequences.

Maintenance risks correspond to the set of operations necessary for the correct functioning of the infrastructure. All actions aimed at making the best use of the road are the responsibility of the concessionaire, which obtains remuneration through the remuneration system agreed in the contract. Therefore, the main risk must fall on the private manager, which may agree with the government on some type of guarantee in the event of alterations in service not attributable to it.

One of the most important risks for an infrastructure project is the risk of demand, which falls outside the real control of private enterprise, since the demand for most PPP projects is exogenous (Engel et al., 2014). Of course, quality of service can induce demand, so some incentives should be transferred to private enterprise to promote the improvement of quality. But macroeconomic variables, land use and urban development, and competing transportation alternatives are the main factors determining traffic demand. Private enterprise has little scope for traffic control and operates in an environment of great uncertainty, especially before the motorway enters into service; particularly when it is a new construction for which there is no past traffic information. The results of traffic predictions for motorway projects are often very poor. In addition, future demand is often overestimated on toll motorways rather than on free motorways (Albalate, 2014, p.197).

Financial risks depend on whether the project's cash flow may fall below the level needed to repay the loans and the capital invested in the project. While governments tend to issue debt, equity and other financial guarantees to reduce the risk premium, it is common to transfer the main financial risks to the private sector. A particularly complex aspect is the fluctuation in exchange rates in projects financed in international markets. Such fluctuations have a direct

impact on the profitability of investments. This risk is usually insured by the state, or by private insurance contracts if the premium is not very high. The Spanish experience shows that allocating this risk to the state can be very damaging to public finances.

The risks of force majeure, such as natural disasters or wars, are totally unpredictable, and it is the administration that usually assumes responsibility for such a contingency, although - when possible - complementary private insurance is often contracted.

The risk of technological progress is a relatively modern contingency, which has its origin in the constant increase of applications and tools adopted as technology advances. The most common requirements that are demanded of the concessionaire consist of the revision and adaptation of regulations concerning the installations of vehicle restraint barriers, safety systems for drivers and safety systems in tunnels. The risks involved in adapting to technical standards are generally borne by private companies.

3. Summary of the Results of the Evolution of Regulatory Frameworks in Spain

From the late 1960s to the present day, more than 2,700 km of state toll motorways have been awarded under PPP contracts. The model for the distribution of concessional risks and state guarantees under which these motorways were awarded has undergone several changes. For practical purposes, we can distinguish four main phases.

Phase I (1967-1972) is characterized by weak legislative regulation, high coverage of financial risk and no mechanism for sharing demand risk. The motorways awarded during this first phase were awarded by means of specific decree-laws for each of the tenders convoked. All of them included regulations and a set of guarantees such as the state guarantee for foreign debt and exchange insurance. The asset was also allowed to depreciate during the first 5 years of operation and the concession period could be extended if the delay in construction was due to force majeure. The revision of tolls was carried out in accordance with the increase in construction and operating costs. The extensions and tax reliefs, the state subsidies (Law 55/1960) and the Administration's Asset Responsibility (RPA) were the guarantees preserved from the previous regulatory framework.

Phase II (1972-1976) is characterized by a specific legislative framework for toll motorways (Law 8/1972 and Decree 215/1973), extension of financial coverage and little progress in covering the risk of demand. For the motorways awarded in this second phase, the right to amortize the asset was extended to the entire concession term and the repayable advances and compensations were introduced to maintain the economic-financial balance, as well as the extension of the concession term for any delay not attributable to the concessionaire itself. State subsidies were permitted when state promotion of a parallel roadway reduced traffic flow on the concessional motorway. The toll review mechanism became linked to increases in service costs. The extensions and tax relief, the state guarantee and exchange insurance and the RPA were maintained.

Phase III (1998-2000) is notable for the change in the model to cover financial risk, the establishment of the extension of the concession term as a mechanism to maintain the concessionaire's economic and financial balance and a new mechanism for toll revision. Given the abolition of the state guarantee and exchange insurance in 1988 (Law 25/1988), in this third phase the administration decided to grant a new set of financial guarantees. In the event that the administration should modify the contracted services and rates, as well as any delay not attributable to the concessionaire itself, the extension of the concession term was established as a guarantee mechanism to restore the concessionaire's economic and financial balance. The update of tolls was established according to the CPI increases. The RPA remained in force.

Phase IV (2002-2006) is notable for the introduction of new mechanisms to restore the concessionaire's economic and financial balance, greater margin in financial risk management and new guarantees, a change in the model for modulating demand risk and a mechanism for measuring service quality. At this stage, the modification of rates or any modification of the particular clauses of the contract's economic content was permitted in order to restore the economic and financial balance of the concessionaire. The model of demand risk changed, with the abolition of non-refundable grants and the introduction of the commitment to limit the maximum and minimum total returns. In addition to increases in the CPI, the updating of tolls would be based on the difference between actual and expected traffic intensity (Law 14/2000). Extensions and tax relief, the extension of the concession period for delay not attributable to the concessionaire, and the RPA, remained in force.

In summary, the results of the Spanish experience show:

- Improvement of the concession model over time with greater coverage of risks that cannot be controlled by the private sector and less coverage of risks that can be controlled.
- A gradual increase in demand risk coverage and some financial risks arising from demand risk (through equity loans, soft loans and price subsidies).
- Limited user coverage in the event of excessive traffic and extraordinary profits, although the latest modifications open up the possibility of reviewing the conditions of the concession in favorable scenarios, since the concessionaire is committed to maximum profitability. However, there is no defined mechanism for profit sharing or changing the terms of the concession.
- Limited protection of the private sector against expropriation risks that do not depend on the concessionaire.
- The coverage of financial risks (such as exchange rate insurance) or maintenance (maintenance tasks with toll revision), which are more controllable by the private manager, is gradually being reduced.
- The risk of construction controllable from the outset is allocated to the private sector and the coverage of non-controllable risks is improved.
- There is little protection for the private sector against public sector decisions in actions that compete with toll motorways (free motorways, high speed railways, etc.), which reduce demand and influence the economic return of the concessionaire.
- High rate of renegotiations in phases of stagnation and economic crisis, due to high debt and low traffic in the first years of concession. Financial and demand risks are decisive factors in renegotiations resulting from project failure.
- The third stage introduces a whole set of risk mitigation mechanisms that has not been sufficient to solve the serious existing problem with the concessions awarded during this period of time.

At all stages, the Administration's Asset Responsibility (RPA) commits the administration to compensate the concessionaire in the event of termination of the concession, as in the case of liquidation due to bankruptcy, which implies a de facto guarantee on the financial risk for its pledge of the company's debt.

4. Crisis and Bailout of the Toll Motorway Concessions

4.1 The Development of New Projects

The toll motorway sector experienced renewed momentum under the People's Party (Partido Popular, PP) government in the late 1990s. The policy on motorway investments and the treatment of operating concessions changed direction after the law accompanying the 1997 budget. Regulatory changes facilitated widespread renegotiations and a new wave of toll road concessions to the private sector.[14] Since 1998, the state has awarded more than 900 km - 15 new motorways or sections - and designed the Transport Infrastructure Plan 2000-2007, which provided a new approach to private participation with the aim of evading the European Union's restrictions on public deficit and debt. In addition, the Empresa Nacional de Autopistas was privatized in 2003. In just five years the government doubled the number of state motorways under private concession.

In 1997, the government studied the profitability of several toll roads, with the result that projects such as the Madrid-Guadalajara, León-Astorga, Ávila-Villacastín, Segovia-San Rafael, Estepona-Guadiaro and the Santiago-Alto de Santo Domingo were shown to require significant subsidies - between 40 and 65% of the total investment - to be profitable (Izquierdo, 1997). However, each and every one of these projects was awarded between 1998 and 2006. Table 2 shows basic information on all projects awarded since 1998.

Among the new concessions were five new radial accesses to the city of Madrid, which already had six toll-free accesses, which in turn included work projects and the operation of free roads to complete the new network. The projects were designed to compete with the free, radial motorways, congested at peak times, allowing the M-40 and M-50 ring roads to be reached in less time. Radial motorways were treated as urgent because of their "exceptional public interest" - based on the urban growth on the outskirts of Madrid and the existing congestion - which made it possible to shorten planning and tendering times.[15]

[14] Notable among these were the renegotiations with the two largest concessionaires, Aumar and Acesa, in 1997 and 1998, respectively.
[15] Order of the Ministerio de Fomento (Ministry of Public Works) of 26 May 1997.

Table 2. Concessions for the construction and operation of toll motorways 1998-2006. Central government road network

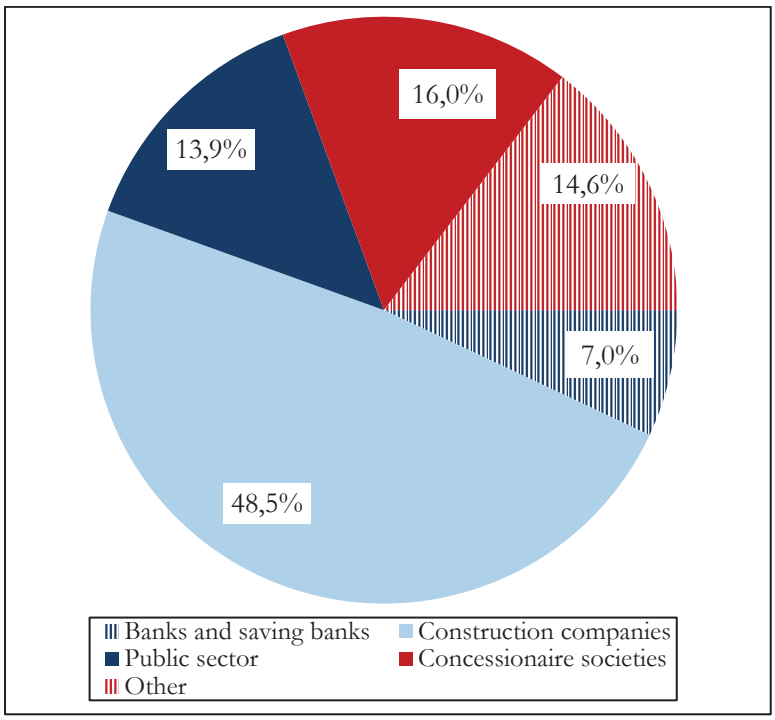
Concessionaire	Road	Award	Expiration date	Years of operation	Year entry operation
AUSUR	Alicante-Cartagena	1998	2048	50	2001
AUSOL	Estepona-Guadiaro	1999	2051	52	2002
AM	R-3 Madrid-Arganda R-5 Madrid-Navalcarnero	1999	2049	50	2004
ACEGA	Santiago-A.S.Domingo	1999	2074	75	2003
CASTELLANA DE AUTOPISTAS	Ávila-Villacastín	1999	2031-36	32-37	2002
	Segovia-San Rafael				2003
AULESA	Léon-Astorga	2000	2055	55	2003
HENARSA	R-2 Madrid-Guadalajara	2000	2039	39	2003
AUTOPISTA MADRID SUR	R-4 Madrid-Ocaña	2000	2065	65	2004
EJE AEROPUERTO	Eje Aeropuerto	2002	2027-28	25-26	2005
AUTOPISTA COSTA CÁLIDA	Cartagena-Vera	2004	2040-44	36-40	2007
AUTOPISTA MADRID-LEVANTE	Ocaña-La Roda	2004	2040-44	36-40	2006
AUTOPISTA MADRID-TOLEDO	Madrid-Toledo	2004	2040-44	36-40	2006
CIRALSA	Circunvalación de Alicante	2004	2040-44	36-40	2007
AUTOPISTA DEL GUADALMEDINA	Alto de las P.-Málaga	2006	2044-47	38-41	2011

Source: *El Tráfico en las Autopistas de Peaje, 2012*. Ministry of Public Works.

The concessions consisted of companies made up of construction companies, banks and savings banks, and infrastructure operators, the majority of which were owned by construction companies, as had traditionally been the case in the sector (see Figure 1). Capital participation in the financing of the companies was limited, and in some cases such as that of Henarsa (R-2 Madrid-Guadalajara), only 12% of the capital was contributed by the shareholders and

the remaining 88% by credit institutions.[16] The expected return for investors was 10%, with profit expectations after the first five years of operation.

Figure 1. Ownership distribution of toll motorway concessionaires



4.2 The Collapse of the Concessions

Currently, eight concession companies (nine motorways) have been declared in suspension of payments (R-2, R-3/R-5, R-4, M-12 Eje Aeropuerto, AP-41 Madrid-Toledo, AP-36 Ocaña-La Roda, Circunvalación de Alicante and AP-7 Cartagena-Vera), while two other concessionaires - Aulesa (León-Astorga) and Ausur (Cartagena-Alicante) - have serious financial viability problems, and a third, Alto de las Pedrizas-Málaga, has needed a renegotiation to restore its economic and financial balance. The bankrupt companies operate 748 km of motorway - although they include 188 free kilometers -, 22% of the network financed by direct toll and practically all the motorways awarded since 1998.

Since 2009, concessionaires with financial problems have received government aid to cover debt service. Toll revenues are insufficient in view of

[16] Among the banks and savings banks involved in financing the Madrid ring roads are Banco Santander, BBVA, La Caixa, Bankia, Deutsche Bank, Banco Popular, Banc de Sabadell, Crédit Agricole, Unicaja, Cajasur, etc.

the high accumulated debt of the concessionaires, 3,800 million euros in 2013, a figure that exceeded 4,000 million in 2014. This enormous indebtedness, which is explained by the limited capital contributed by the partners and by new financing needs in the face of cost deviations, makes it impossible to survive financially without new capital injections. But the partners are not willing to make such contributions due to the unfeasibility of the motorways in their current conditions.

The reasons for the collapse can be found on both the supply and the demand sides of the infrastructure. These factors are summarized below, differentiating between aspects associated with expropriations, construction cost overruns, traffic estimates, public sector action and the impact of the bursting of the housing bubble.

4.2.1 Expropriations

The deviations in costs resulting from the expropriation of land for construction have been widely publicized by the concessionaires. According to the SEOPAN report (2014), some 387 million was expected to be paid, but the total amount paid exceeded 2,217 million. In some cases, the deviation was 600 per cent or more. These deviations were due to court decisions on the disputes in the valuation of the land to be expropriated. Given that Law 6/1998 on the land and valuations system incorporated the market value of the land as a reference for expropriations, the owners demanded that the land be valued as urban, given its proximity to the city of Madrid; it was argued that the expectations of urban growth generated by the motorway itself increased the potential valuation of the land. The courts began to order the inclusion of expectations for future valuation, and, for example, the Tribunal Superior de Justicia of Madrid set an expropriation price of 3,100 euros per square meter on the link between the R-3 (Madrid-Arganda) and the M-40 ring road. The Court considered that the value should be increased due to expectations of urban growth to prevent damage to owners to the benefit of investors (Tribunal Superior de Justicia de Madrid STS 21/07/2008).

4.2.2 Cost Overruns

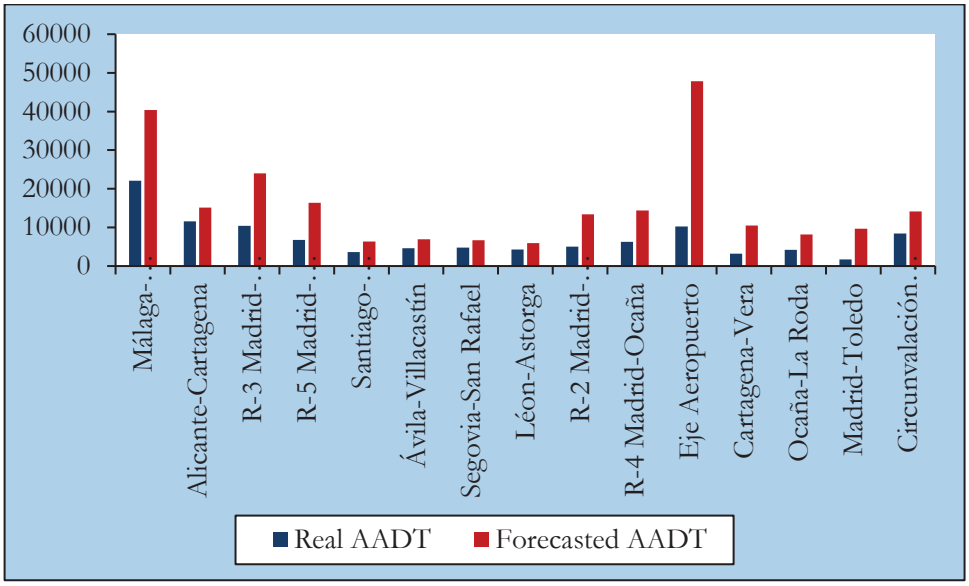
In addition to the deviations caused by the expropriations, there is evidence of significant deviations in the construction costs of the infrastructure project. The

additional costs in the Madrid radial roads range from 15% (R-3) to 31% (R-2) (Vassallo, Ortega and Baeza, 2012). On their own, the recognized and approved increases in the initial investment in the construction of the free collateral network, as required by the government, amounted to 473 million. An example of the origin of these cost overruns is found in the discovery of the paleontological sites of Cerro Batallones and the archaeological sites of Mina Casa Montero, in the initial layout of the R-4.

4.2.3 Traffic Estimates

The crucial factor, however, in explaining the financial collapse are the demand deviations. Figure 2 shows the traffic deviations from the first year of operation. The differences between estimated and actual traffic range from 23% (Alicante-Cartagena) to 82% (Madrid-Toledo) in the first year. The deviations are maintained over the years, as shown in Figure 3, ruling out the expectations of an increase typical of the initial ramp up years.[17]

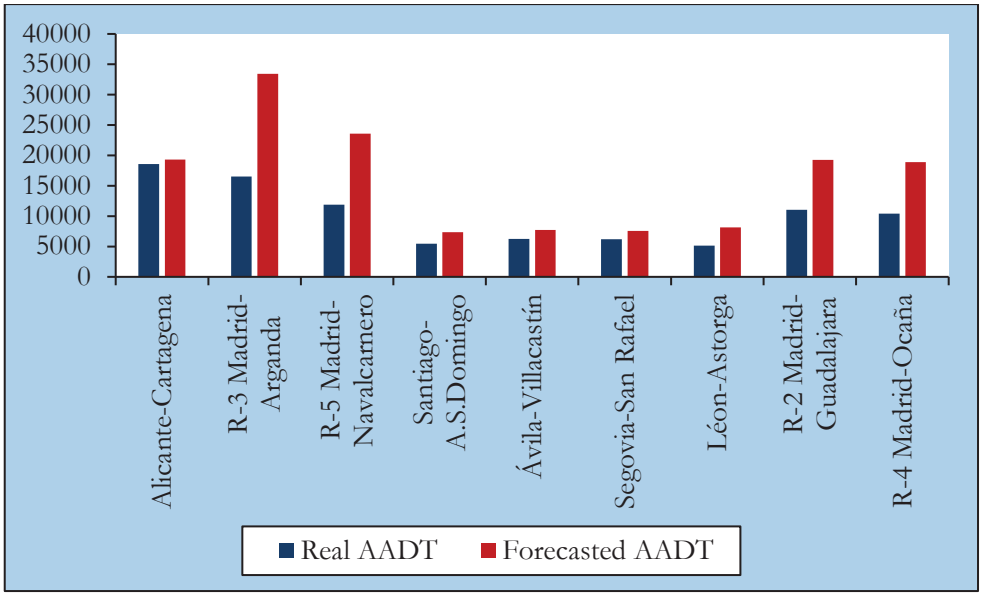
Figure 2. Traffic deviations and real traffic received by motorway concessionaires awarded since 1998. First year of operation



Source: Based on decrees of concessions for forecasted traffic and Ministry of Public Works for real traffic.

[17] The "ramp up" period is the period of the first years after the opening of the motorway. Traffic volume usually increases in the first 3-5 years, and then stabilizes thereafter.

Figure 3. Traffic deviations and real traffic received by motorway concessionaires awarded since 1998. Fifth year of operation



Source: Based on decrees of concessions for forecasted traffic and Ministry of Public Works for real traffic. Note: The number of concessions is smaller in figure 3 because not all the decrees of concessions contained estimates for 5 years.

In fact, as can be seen, the deviations are more pronounced in the case of motorways with free and parallel alternatives. In the case of radial roads, this is also due to the fact that they are not a significantly more attractive solution than free alternatives, since they also end in the congested M-50. While the economic crisis may explain some of these deviations, the traffic deviations in the early years in respect to the actual pre-crisis traffic already show a magnitude of deviation too high to attribute the extent of the mismatch to the economic crisis.

One aspect criticized by private investors is the traffic prediction provided by the state, which they consider excessive and opportunistic to attract private capital. But Baeza and Vassallo (2012) show that the differences between the government's estimates and those of the concessionaires were small and that, where they existed, they were due more to overestimation by the concessionaires. For example, while the deviation from the government's prediction for the R-2 was 46.7%, the concessionaire's prediction deviation was 69.7%. The government provided better predictions than the private sector; the average difference was 7.5% in the concessions examined by Baeza and Vassallo (2012).

4.2.4 Public Sector Actions

Public sector actions have also played a significant role in the collapse of the concessionaires. First, because of competitive investments that affected the capacity of the toll motorways to capture traffic; for example, with the circunvalación de Alicante, which competes with the toll motorway, or with the doubling (under shadow toll) of the M-407 regional road, which competes with the Madrid-Toledo motorway. Second, because of the omission of promised complementary investments; for example, the cancellation of the motorway project between Toledo and Córdoba, which was to complement the Madrid-Toledo motorway, making it an alternative to the A4. A negative environmental report on the impact on the Natura 2000 network in areas where the Iberian lynx and the Iberian imperial eagle are protected lent support to the cancellation of the section to Córdoba. It should be added that the construction of this motorway would have been a new, large white elephant.

4.2.5 The Bursting of the Housing Bubble

Part of the expected profitability of many of the toll motorways awarded was based on the expected increase in traffic resulting from the urbanization of the outskirts of large cities and the urban development of tourist areas. The bursting of the housing bubble played a definitive role in the collapse of the concessions based on these expectations. The paradigmatic example is the Cartagena-Vera motorway, opened in 2007 in an area of great urban development projection based on large-scale projects for the tourism industry in the Spanish Levant.

4.3 The Path of the Collapse of the Concessions

The collapse of the concession companies has led to various types of state actions to support the capacity to repay the debt and avoid the liquidation of the companies. This entails the setting in motion of the administration's asset responsibility and obliges the state to compensate the concessionaires for their liquidation due to bankruptcy. The same award decrees already provided for maximum amounts for this compensation, as shown in Table 3.

The first step to assist concessionaires with problems was taken in the 2010 Budget Law, which provided for the possibility of granting participating loans due to additional expropriation costs and low traffic. Concessionaires could

apply for such loans to finance the additional costs of expropriation in excess of 175%. As a guarantee that the loans could be repaid, the administration would either extend the term of the loan or approve a phased increase in toll rates in order to guarantee income to facilitate loan repayment. Within this framework, in November 2010 the R-2 concession period was extended by almost 15 years. Likewise, the increase in rates was made effective to compensate the concessionaire for the additional costs of carrying out additional works on the motorway and for the additional costs of expropriation. The concession period for the Alto de las Pedrizas-Málaga motorway along with its rates were increased by nearly a year and a half. Concessions of the R-3/R-5 and Alicante-Cartagena motorways also experienced extraordinary rate increases. The loans were incorporated as subordinated debt and enjoyed a three-year grace period (Ridao and García, 2013). The total amount of aid up to the end of 2011 was 502 million.

Table 3. Maximum asset responsibility established in the concession decrees

Road section	Construction RPA	Expropriation RPA
Estepona-Guadiaro	€ 185.604.558,08	€ 9.964.780,69
Alicante-Cartagena	€ 195.889.835,60	€ 24.855.994,24
R-3 Madrid-Arganda R-5 Madrid-Navalcarnero	€ 637.970.000,00	€ 39.040.000,00
Santiago-A.S.Domingo	€ 233.072.494,08	€ 12.020.242,09
Ávila-Villacastín Segovia-San Rafael	€ 255.194.547,62	€ 11.208.875,75
Léon-Astorga	€ 45.075.907,83	
R-2 Madrid-Guadalajara	€ 40.724.580,19	
R-4 Madrid-Ocaña	€ 559.656.461,48	
Eje Aeropuerto	€ 268.498.917,00	€ 36.972.339,00
Cartagena-Vera	€ 496.000.000,00	€ 30.819.000,00
Ocaña-La Roda	€ 462.704.717,00	€ 24.536.532,00
Madrid-Toledo	€ 294.731.000,00	€ 54.155.000,00
Circunvalación de Alicante	€ 309.826.000,00	€ 88.839.000,00
Alto de las P.-Málaga	-	-

Source: Based on Decrees of concessions. Note: In the award decrees of the León-Astorga, R-2 and R-4 toll roads, the value of the RPA is expressed jointly.

Later, Law 43/2010 established the possibility of creating a compensation account through which the state would contribute the difference between 80% of the expected revenues and the actual revenues over the next three fiscal years. The public contributions had to be repaid with interest, just like the participative loans. The annual contributions could not exceed 49% of the annual income plus the amount to be allocated, nor could they exceed the budget allocation, which amounted to just over €80 million in 2011, rising to €290 million in 2012 and €350 million in 2013. The return deadlines for the clearing accounts were first extended to 2018 and then to 2021. However, all these actions have not been able to provide a definitive response to the crisis of these concessionaires, which are in a state of bankruptcy.

5. Discussion and Implications of Public Policy

This study shows that the financial problems of the toll motorway sector in Spain is not an exceptional, one-off circumstance. Indeed, there are sufficient precedents to understand that the results are not the result of chance, an unexpected financial crisis, or periodic poor management by administrations and private investors. Following the analysis and review of the regulatory framework, and in particular of the distribution of risks between the public and private sectors, we have observed how it has evolved and improved over time. However, despite the lessons learned from the negative results of the crisis in the sector in the late 1970s and early 1980s, such reforms have not been able to prevent a new crisis.

The current crisis shares very similar characteristics with its predecessor. It comes after a period of intense activity in the awarding of concessions for the construction of new toll motorways following a period of economic growth. In both periods there was a clear institutional impulse to develop motorways in collaboration with the private sector. And it collapses after the onset of a financial crisis that has a decisive impact on concessionaires because of (1) their huge indebtedness and (2) huge deviations between traffic predictions and the actual traffic received. Both reasons are common in both periods. In addition, the most likely response of the state at present, the nationalization of the highways and their operation by a company with public capital, was one of the main solutions reached in the earlier crisis to give stability to the industry through the creation of the Empresa Nacional de Autopistas. Even so, we have

once again stumbled on the same stone. Will something prevent us from stumbling a third time?

5.1 The Underlying Problem

Despite legislative changes and evidence of blatant problems with predicting demand, the risk-sharing framework still fails to achieve a more balanced allocation of risk, which can lead to concession failure and huge transaction costs with non-transparent renegotiations, but also to extraordinary private sector profits to the detriment of users (Albalate and Bel, 2009). It is noteworthy that the two-tier risk mitigation mechanism, which allows the public and private sectors to share losses, but also profits based on traffic or income, has not been applied to any of the more recent concessions. The model has continued to be based on a private gamble - which apparently allocates all the demand risk to the private sector - with a broad public safety net that limits the impact of a fall, but without a reasonable ceiling to contain the transfer of income from users to investors. In doing so, investors risk only capital that is very limited compared to the share of debt in the financing of concessionaires.

The supply of high-capacity roads in Spain has gone far beyond what would be socially desirable, according to any comparison with surrounding countries. The Spanish motorway network is the longest in the EU, and its intensity of use is very low. The abuse of the Administration's Asset Responsibility (RPA) has facilitated the bidding of private companies in this policy of offer far above mobility and social needs. With the RPA, the risk of financing is limited, and with it, the risk derived from the low traffic that prevents the repayment of the debt. Therefore, a large part of these risks is transferred to taxpayers, when the set of rules would seem to indicate a much greater transfer of risk to the private sector, or even a more balanced distribution than in the past. It is well known that in other institutional and regulatory environments, such as the United States, there is no such guarantee, so that it is possible for concession companies to go bankrupt without compensation. Perhaps this is why PPPs have developed much less frequently in the USA than in the countries of southern Europe and Latin America.

For this reason, we consider it appropriate to remove the RPA from the Spanish regulation on road concessions (a measure that should probably be extended to all transport infrastructures, including energy). This would drastically reduce the use of PPPs for the creation of new infrastructure, which

would be desirable given the current and foreseeable oversupply. The abolition of the RPA would genuinely ensure that a potential new PPP responds to real mobility needs, and that it is not a new white elephant that has managed to avoid budgetary constraints in the short term, for which the government has resorted to pre-financing from private partners, which is ultimately extremely costly in the long term.

Experience shows that if there is the political will to develop new infrastructure that is not strictly necessary in the light of current and future demand, private sector collaboration requires the accommodation of regulation to provide the protection sought by the private sector through guarantees and risk mitigation mechanisms. Only in this way can it be understood that projects which in 1997 revealed the need for generous subsidies were all awarded to the private sector with overly optimistic traffic forecasts and with the participation of all the country's major construction groups and credit institutions. And this without the contribution of the subsidies that were considered necessary, theoretically transferring the main risk to the private sector. Although the regulatory framework has made progress towards a better distribution of risks, the continued existence of the RPA is a de facto guarantee of the concessionaires' indebtedness.

5.2 Recommendations for Improving Risk Distribution

A large part of the risks associated with the motorway business is demand risk. This risk is difficult for the concessionaire to control and requires mechanisms to mitigate its impact on the economic and financial balance. Engel et al., (1997) diagnosed that the main problem was the temporal rigidity of concession contracts and provided as a theoretical response the variable-term concession models that allow for the internalization of demand risk through a mechanism of automatic adjustments in the concession period. However, this model still has no practical presence in Spain.[18] The variable-term concession contract is much more common in Chile, where it has become a standard model for motorway concessions. We believe that variable-term contracts should be

[18] Only the government of Aragón took into consideration this formula for the contract of the construction and operation of the Cariñena-Gallur motorway, although in the end it was not used.

considered more seriously, as they allow for a mitigation of the main business risk and therefore lower risk premiums.

Apart from traffic, legislative reforms have also failed to mitigate other risks that have proved relevant in the current crisis. Although the state prefers that the concessionaire carry out expropriations in order to avoid having to provide resources from the administration, experience shows that this is an uncontrollable risk for the concessionaire. In fact, countries considered to have good practice in the area of concession regulation, such as Chile, assign the risk of expropriation to the public sector. It seems reasonable that this should be implemented in the same way in Spain.

Other aspects that have harmed the sector are the non-inclusion of specific non-competition clauses - in alternative projects - and the failure to define compensation for these, which leaves it up to the courts whether or not to require compensation in accordance with the commitments to maintain the economic balance of the concession.

Finally, the role of construction companies as partners in the ownership of concessionaires and as subcontractors for construction raises enormous doubts about possible strategic opportunistic behavior. While in the short term the construction companies obtain the benefits of the construction of the work, they share the limited capital losses with the rest of the partners, banks and infrastructure operators. This would require the attention of the authorities responsible for defending competition and sector regulation.

5.3 What to do in the Short Term?

Despite these reflections on the infrastructure policy model and the design of long term public-private partnerships, the current crisis in the sector requires immediate government intervention to prevent the rescue from causing serious damage to taxpayers, in addition to damaging public spending and public sector debt ratios. The government seems to be in favor of nationalization and creating a "bad bank" of motorways with mixed capital, but there are other solutions for a definitive stabilization of the sector.

The first, similar to the one used in the 1980s, is the restructuring of the industry based on mergers between companies. This policy would promote the absorption of loss-making companies by profitable companies in exchange for renegotiations of the most profitable concessions, for example through

extensions of concession periods. This solution poses major economic and political problems. From an economic point of view, it involves the imposition of a model of cross-subsidies between users in different regions - a problem of efficiency and territorial equity - which in turn leads to a political problem. The mixed financing model in Spain concentrates in certain territories the payment for the use of motorways, while in other territories usage is financed by the public budget, and therefore also by the general taxes paid by users of toll motorways. This double taxation is a major territorial political problem.

A bailout of the concessions in exchange for affecting the profitable concessions would impose additional costs on users in the regions with the highest concentration of profitable tolls for the use of oversized motorways and which would benefit, under cross-subsidization, users who generally have free parallel infrastructures. Perhaps this is the idea of the Ministry of Public Works following the announcement of the completion of the concession of the AP-7 in its southern section in 2019, without the possibility of extension.[19] This announcement could indicate that the government intends to include the AP-7 in the new public motorway company with the aim of using the resources of the profitable motorways to clean up the nationalized companies in the wake of the current financial crisis.

Another alternative would be to take advantage of the crisis in the sector to correct the historical anomaly of the heterogeneous financing model by extending the pay-per-use criterion to the entire free motorway network. This would make it possible to comply with the Eurovignette Directive and to start on a path towards internalizing the costs incurred by the use of the infrastructure by users. Payment for use (tolls, vignettes, etc.) has been a growing trend in Europe in recent years. This alternative would allow the whole network to provide the necessary resources. To this end, a public or mixed company could be set up to nationalize motorways with problems, or the troubled private sector could be granted new concessions for the operation and maintenance of motorways that are now free, to operate and maintain them in such a way as to permit their long-term economic and financial equilibrium. However, the main obstacle to this alternative is social opposition to an unpopular measure.

[19] The Secretary of State for Infrastructure, Rafael Catalá, announced to the network of mayors of La Marina Alta that the AP-7 motorway between Valencia and Tarragona would be liberalized in 2019, the year of the termination of the current concession.

If electoral considerations prevent progress in extending tolls as a mechanism for financing motorways on the network as a whole, another alternative is a limited extension to the territory directly affected by bankrupt motorways. As motorways are infrastructures with a localized territorial influence, it makes sense for the users who enjoy the infrastructures to bear the costs. In this sense, an alternative solution is the imposition of direct toll concessions for the operation and maintenance of free motorways that act as the main competitors of toll motorways. This would allow for the rehabilitation of troubled concession companies or the viability of a national motorway company in a manner similar to the extension of tolls over the entire network.

6. A General Conclusion on Objectives and Instruments

It is appropriate to conclude this analysis with a more general observation on the effects of public policy. Regulation is an instrument of policy, and policy pursues objectives. Therefore, it is not enough to make specific changes to the regulatory framework, but rather a change in the approach to infrastructure policy itself is necessary. If governments continue to promote infrastructure projects that do not correspond to real mobility needs, and seek to involve the private sector in their implementation, there will always be some measure, such as the administration's asset responsibility (RPA), that facilitates over-investment.

In short, the only way not to stumble on the same stone for the third time is to change the direction of the infrastructure policy and to adapt the design of the projects to the real demands of mobility. Our neighbors in central and northern Europe have many lessons from which we may learn in terms of the planning and selection of projects.

References

Albalate, D., 2014. The Privatisation and Nationalisation of European Roads: Success and failure in Public Private Partnerships. Cheltenham: Edward Elgar.

Albalate, D., Bel, G., 2009. Regulating concessions of toll motorways: An empirical study on fixed vs. variable term contracts. Transportation Research Part A, 43(2), 219-229.

Albalate, D., Bel, G., Fageda, X., 2015. When supply travels far beyond demand: Causes of oversupply in Spain's transport infrastructure. Transport Policy, 41, 80-89.

Baeza, M.A., Vassallo, J.M., 2008b. Traffic uncertainty in toll motorway concessions in Spain: an analysis of the ramp-up period. TRANSyT 2008-01, Universidad Politécnica de Madrid; Workin Paper.

Baeza, M.A., Vassallo, J.M., 2012. Traffic uncertainty in toll motorway concessions in Spain. Proceedings of the Institution of Civil Engineers-Transport, 165(2), 97-105.

Bel, G., 1999. Financiación de infraestructuras viarias: La economía política de los peajes. Papeles De Economía Española, 82, 123-139.

Bennett, J., Iossa, E., 2006. Building and Managing Facilities for Public Services. Journal of Public Economics 90(10-11), 2143-2160.

Engel, E., Fischer, R., Galetovic, A., 1997. Highway franchising: pitfalls and opportunities. The American Economic Review, 87(2), 68-72.

Engel, E., Fischer, R., Galetovic, A., 2009b. Public-private partnerships: when and how. Stanford Center for International Development; Working Paper.

Engel, E., Fischer, R., Galetovic, A., 2014. The economics of public-private partnerships. A basic guide. Cambridge: Cambridge University Press.

Gómez-Ibáñez, J.A., Meyer, J.R., 1993. Going private: The international experience with transport privatization. Washington, DC: The Brookings Institution.

Iossa, E., Martimort, D., 2015. The simple microeconomics of public-private partnerships. Journal of Public Economic Theory, 17(1), 4-48.

Izquierdo, R., 1997. Gestión y financiación de las infraestructuras de transporte terrestre. Madrid, Asociación Española de la Carretera.

Martimort, D., Pouyet, J., 2008. To build or not to build: Normative and positive theories of public-private partnerships. International Journal of Industrial Organization 26(2), 393-411.

National Audit Office (NAO), 2003. PFI: Construction Performance, HC 371. London, UK: National Audit Office.

National Audit Office (NAO), 2009. Performance of PFI construction. A review by the private finance practice. London, UK: National Audit Office.

Prior, J., Puelles, J.J., 2012. La financiación de las concesionarias de autopistas. In: Morera, J.M., Prior, J. (Eds.), Las Autopistas de Peaje en España. Madrid: ASETA, 54-63.

Puncel, A., 1996. La Autopista del Mediterráneo: Cesiones, concesiones, servicios y servidumbres. Valencia: Servei de Publicacions de la Universitat de València.

Ridao, J., García, A., 2013. La precaria viabilidad de determinadas concesiones de autopistas de peaje en España. Lecciones estructurales para el modelo de colaboración público-privada y una propuesta de solución coyuntural. Revista Andaluza de Administración Pública, 87, 95-135.

Robinson, J.A., Torvik, R., 2005. White elephants. Journal of Public Economics, 89(2-3), 197-210.

SEOPAN, 2014. Infraestructuras, consideraciones, desafíos y previsiones. Available in www.seopan.es

Vassallo, J.M., Ortega, A., Baeza, M.A., 2012. Impact of the economic recession on toll highway concessions in Spain. Journal of Management in Engineering, 28(4), 398-406.

World Bank, 2012. Public-Private Partnerships reference guide. The World Bank.

Chapter 3

Winners and Losers in Toll Motorway Renegotiations: An Empirical Evaluation of the Spanish Pioneers

This article evaluates the welfare impact of a pioneer tolled motorway contract renegotiation in Spain. The results show that, after renegotiation, both taxpayers and the private concessionaire were better off. However, road users lost out. An agreement leaving road users unaffected, while securing gains for taxpayers and the concessionaire, would have been possible by negotiating a larger reduction in tolls linked to the extension of the contract duration.

Keywords: concessions, renegotiations, motorways, tolls, welfare.

JEL Codes: H43, L91.

1. Introduction

Financial and budget constraints lead many governments to seek funding for strategic transportation infrastructure projects in the private sector. As a result, there is a growing presence, across the globe, of private interests in joint undertakings with the public sector. Under such agreements, private partners are involved in the design, construction, management and funding of many transportation projects. The increase in public-private partnerships (PPPs) in this area is well documented, but their presence is particularly notable in the toll road sector, above all in Latin America (Guasch, 2004; Guasch et al., 2008; Engel et al., 1996, 2003b), Southern Europe (Albalate et al., 2009; Albalate, 2014) and recently in the United States (Engel et al., 2006a; Bel and Foote, 2009).

The standard model for contracting out road projects when constructing new infrastructure (greenfield projects) and introducing a payment mechanism based on user payments, with or without budget contributions, is referred to as a build, operate and transfer (BOT) model[20]. Here, the state awards the project by way of competitive auction or bilateral negotiation to a private company and the concessionaire then designs, builds, finances and maintains the infrastructure for a stipulated time period, charging fees to users or taxpayers (shadow tolls). When a concession terminates, operation is transferred to the state. However, recent experience shows that this model generates frequent and early renegotiations for various reasons, including poor contract design with agreements being inherently incomplete (Kerf et al., 1998); deficient traffic prediction models, undermined by poor long-term forecasts and uncertain traffic demand (Bain, 2009); fixed contract duration (Engel et al., 1997; Engel et al., 2001); and the strategic behavior adopted by companies in the bidding process (Athias and Nuñez, 2008).

Spain is one of the most experienced countries with regards to private participation in the toll motorway industry, using mainly BOT contracts. The model was introduced in the late 1960s and subsequently developed to obtain funding for strategic investments. The country's tolled motorway network exceeds 3,000 km in length and more than 60% of tolled roads have undergone at least one contract extension renegotiation. Most of these renegotiations have been the result of contractual incompleteness and the fixed-term nature of the

[20] The literature also recognizes other contract types including build, own, operate and transfer (BOOT); build, transfer and operate (BTO); design, build, finance, and operate (DBFO), rehabilitate, operate and transfer (ROT).

concession, inaccurate forecasting or economic crises that have affected both costs and demand.

The most recent wave of renegotiations in Spain took place in the late 1990s as the government sought to comply with the Maastricht Treaty. This involved the renegotiation of several tolled motorway concessions, with contractual extensions being granted in return for lower tolls that could both transfer and reduce logistical costs. These agreements resulted in a significant increase in demand, and meant that many concessions that were due to be terminated in the early 2000s remain in private hands despite public discontent, especially in areas where tolled roads concentrate (see Albalate, 2014). Today, Spain operates a mixed funding model where about 80% of its motorways are publicly funded and 20% are financed with user fees (Bel and Fageda, 2005; Albalate, 2011).

By focusing on one representative process of renegotiation during this last wave of contract extensions in Spain, this paper makes two main contributions. First, this is – as far as we know – the first paper to identify and measure the effect of welfare changes provided by a tolled motorway renegotiation disaggregated by agents (users, concessionaires and taxpayers). As such, this paper seeks to identify the winners and losers in this renegotiation that saw tolls being reduced and contracts extended. Second, we perform a welfare analysis (WA) that can be used as a benchmark for implementation when examining the financial welfare effects of any ongoing or finalized toll motorway renegotiation.

The remainder of this paper is organized as follows. In the next section, we briefly review tolled road policy and its development in Spain paying special attention to the tolled motorway concession analyzed here. Section three describes the methodology adopted in computing our WA. The fourth section presents our main results and the paper concludes with final remarks and conclusions.

2. Tolled Motorway Concessions and Renegotiations in Spain

During the 1960s, the Spanish economy grew rapidly, giving rise to a need for more highways. This was tackled in 1965 via a national motorways program. Between 1967 and 1975, private firms constructed more than 2,000 kilometers of tolled roads, but the onset of the democratic transition, the economic crisis and a dramatic increase in construction and energy costs paralyzed the plan. In the early 1980s, following the political transition, a left-wing government opted

to build new highways from public funds, while retaining tolls on the motorways already constructed, resulting in a mixed motorway-funding model (Bel, 1999). This mixed model was further complicated by a series of renegotiations and privatizations due to the financial crisis; in fact, three concessionaires had to be taken into public ownership in 1984. However, policies favoring tolls introduced in 1996 (following a change of government), and plans to boost economic efficiency and fight inflation in seeking to comply with the Maastricht Treaty, exacerbated the situation. Between 1996 and 2004, the conservative party awarded 900 kilometers of new tolled motorways to private companies and extended the duration of the concession contracts awarded during the dictatorship. The motorway most affected by these renegotiations, and the subject of this study, was the AP-7. Today, the contracts for the radial motorways providing access to Madrid, which were awarded in the early 2000s, are being reviewed, due to the poor financial situation. Renegotiations are likely to increase; there could also be some nationalizations.

2.1 Case Study: The Tarragon-Valencia and Valencia-Alicante Sections of the AP-7 Motorway

The AP-7 is a 980 kilometer of tolled motorway (operated under a PPP) that runs along the Mediterranean coast, from the French border to Algeciras in the south of Spain. The alternative conventional road, the N-340, which is completely public and toll free, runs parallel to it. The AP-7 was the first motorway concession to be awarded in Spain in the late 1960s and today comprises 18 sections managed by six different private companies. Different sections of the AP-7 have been renegotiated, with the most recent agreements being reached in the late 1990s. This paper analyses the 1997 renegotiations of the Tarragona-Valencia and Valencia-Alicante sections; these sections have a combined length of 374 km and have some of the highest average daily traffic volumes in the corridor.

The last renegotiations of these sections (31 October 1997) were, according to government sources, aimed at stimulating the use of the motorway in corridors of high economic activity that were absorbing high volumes of traffic. The main changes in the contracts were 34.66 and 32.37% toll reductions on the Tarragona-Valencia and the Valencia-Alicante sections, respectively, and a

24 million euro[21] concessionaire investment commitment in new flexible road safety barriers, new road links, access improvements and information system modernization.

The toll reductions apply until the end of the concession, and the investment was to be made between 1998 and 2000. As compensation, the concession was extended by 13 years, from 31 December 2006 (the previous termination date) to 31 December 2019.

3. Empirical Strategy

This paper evaluates the welfare impacts of a concession renegotiation involving one of Spain's main tolled motorways channeling high volumes of traffic along the strategic Mediterranean corridor. The AP-7 concession was last renegotiated in 1997 and there have been no similar renegotiations in this sector since. We empirically estimate welfare changes disaggregated by agents in order to determine the main losers and winners of this policy. To do so, we conducted a WA of the actual situation (the renegotiation) and compared these outcomes with a simulated situation (no renegotiation). The three agents included in our WA were: (1) road users, including those using the motorway and those using the free, parallel, conventional road (N-340) (2) the concessionaire, i.e., the private company operating the two motorway sections, and (3) the government or taxpayers, because the central government in Spain is responsible for both the motorway and the toll-free route.

Welfare was considered for the renegotiation scenario or the current situation (the last renegotiation between the state and the concessionaire was on 31 October 1997, with the concession due to terminating on 31 December 2019), and for a no renegotiation scenario (with the concession terminating on 31 December 2006 and the two sections being transferred to the state in 2007). Upon termination of the concession the government has to decide if the motorway should be free, a reasonable assumption if we consider that 80% of the total km of motorway in Spain are toll free, or whether the road users should pay cost-based tolls (assuming that the government does not want to mark a profit).

[21] The renegotiation included a further six million euros for the Sevilla-Cadiz (AP-2) section belonging to the same private firm as the Tarragona-Valencia and Valencia-Alicante sections.

3.1 Methodology

The WA was conducted over a time horizon of 23 years (1997-2019), corresponding to the new concession period. First, we conduct the WA for the renegotiation scenario (R), assuming that road users pay the reduced toll rate from 1997 to 2019 as per the agreement reached. The concessionaire operates and maintains the motorway throughout the period and makes a compulsory investment of 24 million euros (1998-2000).

The government operates the conventional parallel route (N-340) throughout the period and collects taxes (VAT) from the concessionaire's revenues. In the alternative scenario of no renegotiation (NR), the concession terminates in 2006 and between 2007 and 2019 the government has to bear not only the maintenance costs of the N-340 but also the cost for operating and maintaining the motorway and the 24 million euro investment deemed essential for the good operation of the motorway. In the NR scenario, we first assume that the government does not charge a toll, as is currently the case on most publicly managed motorways in Spain. This means road users only pay a toll between 1997 and 2006 when the concessionaire operates the AP-7, but not after this date. We denote this scenario as NR1. Second, we relaxed this assumption and assumed that the government charges cost-based tolls to road users to cover maintenance costs (road users pay tolls throughout the whole period: those actually charged by the concessionaire up to 2006 and cost-based tolls between 2007 and 2019). This is our scenario NR2. The WA for each scenario and each agent was calculated using equation 1:

$$WA_i^{\alpha} = \sum_{t=0}^{t=n} \frac{Benefits_t - Costs_t}{(1+r)^t}$$

where,

i=each of the agents involved in the scenarios: road users (U), concessionaire (C) and taxpayers (G); α=each of the scenarios considered: α=R renegotiation; α=NR1 no renegotiation and the government does not charge a toll following the transfer of the infrastructure to the state; α=NR2 no renegotiation and the

government charges a cost-based toll when the infrastructure is transferred to the state; t=years; r=social discount rate of 5.5%[22]

First, we calculated the net result of renegotiation in terms of the differences between the costs and benefits for each agent in the actual renegotiation scenario. We then computed the net cost-benefit outcome for each agent in the NR scenario (with and without tolls, separately). The costs and benefits included in the analysis are shown in Table 1.

Table 1. Cost-benefit matrix comparing the alternative for agents

	Road users
Costs	
R	Reduced toll payments (1997-2019) Annual time costs travelling on the motorway (1997-2019) Annual time costs travelling on alternative conventional road (1997-2019)
NR1	Real toll payments (1997-2006) Annual time costs travelling on the motorway (1997-2019). Annual time costs travelling on alternative conventional road (1997-2019)
NR2	Real toll payments (1997-2006) Cost-based toll payments (2007-2019) Annual time costs travelling on the motorway (1997-2019) Annual time costs travelling on alternative conventional road (1997-2019)
	Concessionaire
Costs	
R	Maintenance costs motorway (1997-2019) Operational costs motorway: disposal costs, depreciation costs, financial expenses costs and corporate income taxes costs (1997-2019) Compulsory investment costs in the motorway (1998-2000)
NR1	Maintenance costs motorway (1997-2006) Operational costs motorway: disposal costs, depreciation costs, financial expenses costs and corporate income taxes costs (1997-2006)
NR2	The same costs as NR1

[22] In order to obtain the social discount rate (SDR), we adhered to the approximation of the Social Time Preference Rate (STPR). We take the 5.5% rate in line with the estimates obtained by Souto (2001) for Spain.

Table 1. *(Continued)*

	Concessionaire
Benefits	
R	Net Revenue tolls collected by the concessionaire after discounting VAT (1997-2019)
NR1	Net Revenue tolls collected by the concessionaire after discounting VAT (1997-2006)
NR2	The same benefits as NR1
	Taxpayers
Costs	
R	Government annual maintenance costs for the alternative conventional road (1997-2019)
NR1	Government annual maintenance costs for the alternative conventional road (1997-2019) Compulsory investment costs in the motorway (2007-2009) Government annual maintenance costs for the motorway (2007-2019)
NR2	The same costs as NR1
Benefits	
R	Corporation Taxes (1997-2019) VAT (1997-2019)
NR1	Corporation Taxes (1997-2006) VAT (1997-2006)
NR2	Corporation Taxes (1997-2006) VAT (1997-2019) Net revenue cost-based tolls collected by the government after discounting VAT (2007-2019)

Notes: Road users have no benefits in any of the scenarios considered. R=Renegotiation, NR1= No Renegotiation if the government does not charge tolls to road users when the motorway is transferred to the state. NR2= No Renegotiation if the government charge cost-based tolls to road users when the motorway is transferred to the state.

We considered the annual travel time costs on the motorway (AP-7) and on the conventional road (N-340) as the main welfare determinant for road users, but could not include intangible welfare factors such as convenience, comfort, safety or utility obtained from the trip etc. Thus, we considered the total time spent on each of the roadways in computing road user welfare, plus the tolls charged to those using the AP-7, which is the standard generalized transportation cost approach implemented in transportation economic modelling.

As such, average daily traffic is a key variable since all costs and benefits depend to some extent on it[23] – in this respect, prices have a clear impact on average daily traffic. As our simulated scenarios (NR1 and NR2) imply price changes, we took the -0.5% elasticity price, obtained from the estimates for Spain by Matas and Raimond (2003), to compute the resulting traffic after price modifications.

Having computed the net results for all agents (see equation 1), which provided us with an absolute comparison between renegotiation and no renegotiation, we then measured the relative welfare change resulting from renegotiation following equation 2:

$$\Delta W_i^g = \frac{|WA^R - WA^{NR}|}{WA^R} \times 100$$

where, i=each of the agents involved in the scenarios: road users (U), concessionaire (C) and taxpayers (G); g=no renegotiation government parameter (g=1 if the government does not charge a toll following the transfer of the infrastructure to the state and g=2 if the government charges a cost-based toll when the infrastructure is transferred to the state); $|WA^R - WA^{NR}|$ = net result of the renegotiation; WA^R = welfare analysis outcome in the renegotiation scenario; WA^{NR} = welfare analysis outcome result in the no renegotiation scenario, NR=NR1 if g=1 and NR=NR2 if g=2.

We present these outcomes in relative terms: first, because we want to identify the winners and losers in the renegotiation process; and, second, because we cannot specifically calculate the benefits for road users as their welfare gains are based on the time and monetary savings that make up the two cost variables in the generalized transport cost equation.

4. Results

Table 2 shows the disaggregated and specific cost-benefit outcomes and their component factors for road users in absolute terms for each scenario. According to these estimates, the best scenario for road users is that in which there is no renegotiation of the concession and the government does not charge tolls when the infrastructure is transferred back to the state. Even if the government opts to charge cost-based tolls, road users were still better off than

[23] Apart from compulsory investment costs that are fixed by law.

in a scenario of renegotiation and contract extension because the toll rates under the renegotiation scenario were higher per vehicle-km than those charged by the government. Further, because time costs per user on the motorway were lower than those on the conventional road, more users would take the motorway if prices were lower than in a scenario of renegotiation. This means higher time costs in absolute terms for the motorway users in both no renegotiation scenarios (NR1 and NR2) than in the renegotiation scenario (2,832.98 M euro > 2,797.98 M euro > 2,564.09 M euro), primarily because more drivers will use the tolled motorway when it is cheaper (or free), but the time cost per driver is much lower due to the faster journey time. As expected, aggregate toll payments decrease in scenarios NR1 and NR2, particularly when the government does not charge a toll. In short, road users are clear losers in renegotiations.

Table 2. Road user WA for each alternative in 1997 values

Costs	**R**	**NR1**	**NR2**
Toll payments	3,160.14 M	2,145.10 M	2,302.15 M
Time costs: motorway	2,564.09 M	2,832.98 M	2,797.98 M
Time costs: alternative road	4,076.15 M	4,080.30 M	4,129.56 M
WA	-9,800.38 M	-9,058.38 M	-9,229.68 M

Note: Road users have no benefits in any of the scenarios considered.

Table 3 shows the disaggregated and specific cost-benefit outcomes and their component factors for concessionaire in in absolute terms for each scenario. According to our estimates, the best scenario is renegotiation (952.12 M euro). This is because the concessionaire is able exploit the motorway over a longer period, offset the lower toll rates and the compulsory investment imposed in the renegotiation. Interestingly, however, the WA for a scenario without renegotiation still gave the concessionaire a healthy outcome (679.45 M euro) because it could charge a higher toll rate until 2006 and avoid the compulsory investment. It is reasonable to assume that the concessionaire, aware of its profit levels without renegotiation, will negotiate better conditions in order to reach an agreement. In short, the concessionaire is a clear winner in this renegotiation.

Table 3. Concessionaire WA for each alternative in 1997 values

Costs	**R**	**NR1**	**NR2**
Maintenance: motorway	192.84 M	121.29 M	121.29 M
Operational: motorway	1,592.96 M	1,111.37 M	1,111.37 M
Investment: motorway	22.89 M		
Benefits	**R**	**NR1**	**NR2**
Net revenues: motorway	2,760.81 M	1,912.12 M	1,912.12 M
WA	952.12 M	679.45 M	679.45 M

Table 4 shows the disaggregated and specific cost-benefit outcomes and their component factors for taxpayers in absolute terms for each scenario. Our estimates show that the best cost-benefit scenario is renegotiation, which is what happened in the reality. The government does not have to manage the motorway nor invest in it between 2007 and 2019, these costs being borne by the concessionaire and financed by road users. Moreover, the government collects tax revenues (VAT) from the tolls charged for a longer period than in the case of no renegotiation. These factors appear to be the main sources of gain associated with renegotiation. Cost-benefit outcomes in alternative scenarios show the government doing better charging cost-based tolls as opposed to operating the motorway free of charge.[24]

Clearly this result is driven by the fact that by charging cost-based tolls, taxpayers avoid any maintenance costs, while VAT continue to be collected from the publicly owned company managing the motorway. Thus in scenario NR1 (no cost-based tolls), the net gain to taxpayers is lower than the net gain in scenario NR2 (cost-based tolls). As such, their net gain (516.61 M euro) is closer to the net gain under renegotiation (788.49 M euro) than in the alternative case of free motorway use (396.09 M euro). Note that all net outcomes are positive, which means in all scenarios the government's VAT revenues are higher than its expenditure on the maintenance of both roadways (the N-340 throughout

[24] Note that the maintenance costs of the N-340 are higher under no renegotiation. A possible explanation is that until 2006 tolls are higher than in the renegotiation scenario and so many drivers continue to use the free, parallel route (maintenance costs being a function of traffic). These costs are not offset by the savings made after 2007 when the toll falls or is even lifted. Indeed, maintenance costs appear to be lower when the motorway is free (NR1).

the period and the AP-7 in both no renegotiation scenarios). In short, taxpayers are clear winners in the renegotiation.

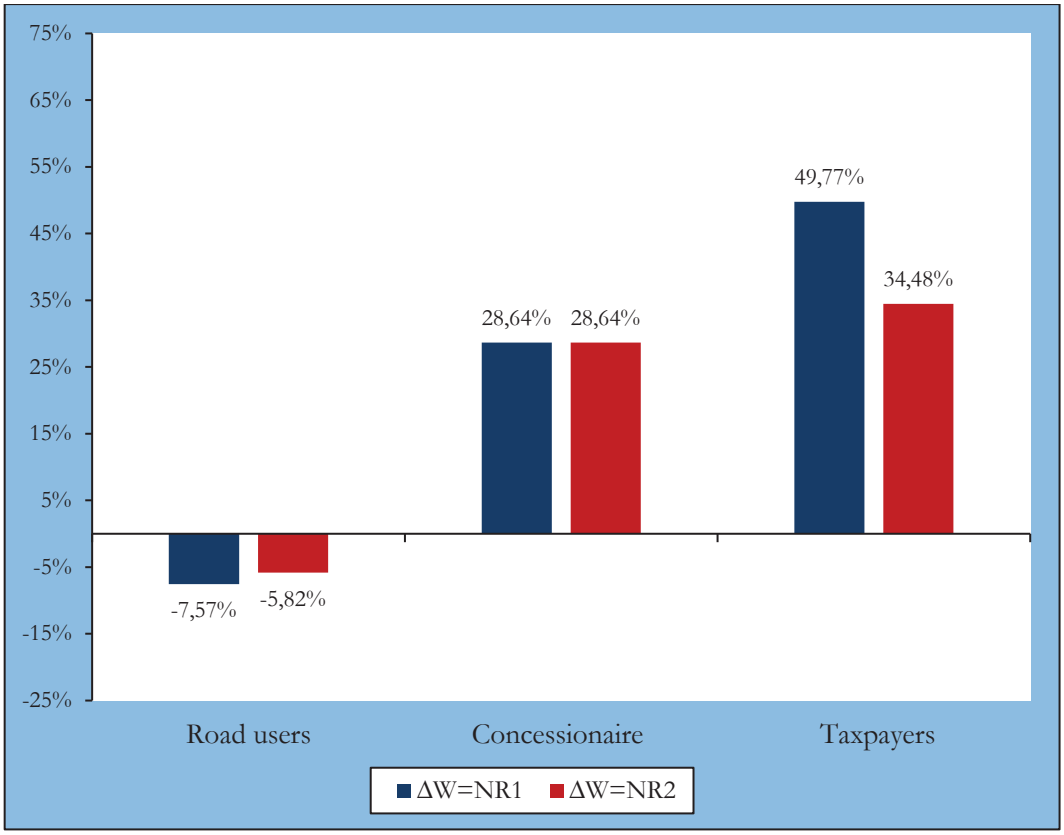
Table 4. Taxpayers WA for each alternative in 1997 values

Costs	**R**	**NR1**	**NR2**
Maintenance: alternative road	91.84 M	94.97 M	95.86 M
Maintenance: motorway	-	97.04 M	132.68 M
Investment motorway	-	17.93 M	17.93 M
Benefits	**R**	**NR1**	**NR2**
Net revenues motorway	-	-	132.68 M
Corporation tax	481.00 M	373.04 M	373.04 M
VAT	399.33 M	232.98 M	257.35 M
WA	788.49 M	396.09 M	516.61 M

In relative terms (see Figure 1), the main losers in the renegotiation are road users, with a change in welfare of between -5.8% and -7.6%, depending on the government's toll policy in the no renegotiation scenarios. The worst outcome is obtained by comparing a scenario of renegotiation with that of no renegotiation and the government charging of cost-based tolls after 2007.

Relatively speaking, the winners of the renegotiation were those that agreed terms in 1997: the concessionaire and the government (taxpayers). In fact, the agents experiencing the largest relative welfare changes were the taxpayers in each of the scenarios, regardless of the toll policy in alternative scenarios of no renegotiation. Thus, the concessionaire always obtains welfare gains (+28.64%) from the renegotiation and is indifferent to the toll policy adopted by the government, and the taxpayers experience a welfare change between +49.8 and +34.5% from the renegotiation, the highest value being associated with the scenario in which the government does not charge tolls after 2006. By contrast, the agents not directly involved in the renegotiation, i.e., the road users, experienced a significant welfare loss across all scenarios.

Figure 1. Welfare impact of the renegotiation by agents in 1997 values (percentage changes)



Notes: NR1= No Renegotiation if the government does not charge tolls to road users when the motorway is transferred to the state. NR2= No Renegotiation if the government charge cost-based tolls to road users when the motorway is transferred to the state.

The road users' loss could easily have been offset with a larger toll reduction in the 1997 renegotiations (fixed at 34.66 and 32.37% on the Tarragona-Valencia and the Valencia-Alicante sections, respectively). Adopting the same empirical strategy as above, we can compute the reduction that would have left road users indifferent to the renegotiations.

Table 5 shows impacts assuming different toll reductions, so that reductions of 46.3% and 44.1% (depending on the government's toll policy in the no renegotiation scenarios) would have left road users indifferent. Interestingly, these toll reductions would still have provided the concessionaire and the taxpayers with positive welfare changes.

Table 5. Welfare impact of the renegotiation by agents in 1997 values according to different toll reduction assumptions (percentage changes)

Toll reductions in renegotiation scenario (R)	*Welfare impact NR=NR1*			*Welfare impact NR=NR2*		
	Road users	Concessionaire	Taxpayers	Road users	Concessionaire	Taxpayers
Real reduction (32,66%-34,66%)	-7,57%	28,64%	49,77%	-5,82%	28,64%	34,48%
43,80%	-1,68%	23,65%	45,11%	-0,14%	23,65%	31,20%
43,90%	-1,61%	23,59%	45,06%	-0,08%	23,59%	31,16%
44,00%	-1,55%	23,52%	45,00%	-0,01%	23,52%	31,11%
44,10%	-1,48%	23,46%	44,94%	0,05%	23,46%	31,06%
44,20%	-1,41%	23,40%	44,88%	0,12%	23,40%	31,02%
46,00%	-0,19%	22,22%	43,77%	1,31%	22,22%	30,14%
46,10%	-0,12%	22,15%	43,70%	1,38%	22,15%	30,09%
46,20%	-0,05%	22,08%	43,64%	1,45%	22,08%	30,03%
46,30%	0,02%	22,01%	43,57%	1,51%	22,01%	29,98%
46,40%	0,09%	21,94%	43,51%	1,58%	21,94%	29,93%
46,50%	0,16%	21,87%	43,44%	1,65%	21,87%	29,88%

5. Conclusions

Spain has been a pioneer in the use of PPPs in the road sector and so is a good case study for analysing and evaluating the performance of such partnerships. However, while Spain has experienced many renegotiations of its tolled motorway PPPs, no study to date has evaluated their real impact on the welfare of the actors involved. Typically these renegotiations involve a change in the tolls charged and the duration of the contract. Indeed, most of Spain's mature motorway concessions have been extended so as to compensate the private concessionaire for a reduction in tolls or for new investments, but the population are largely unaware of the long-term effects of these decisions on the welfare of road users, the private concessionaire and taxpayers.

This study has shown that the two agents involved in renegotiating the concession – the private concessionaire and the government – for one of the oldest and busiest tolled motorways in Spain have benefited most, in absolute and relative terms, from changing the contract. This means that those who bilaterally renegotiated the contract benefited from it at the expense of the road users, who suffer a welfare loss, even though tolls are reduced in the short term. The main winner was the government (or the taxpayer), which would account for the fact that many such renegotiations are led by the administration. Indeed, when the government renegotiates the length of a BOT contract in which tolls are paid directly by the users, it can secure notable welfare gains by extending its duration. This is because governments can collect taxes for longer periods under private management and make cost savings by avoiding any maintenance and operation costs.

Reducing tolls but extending the length of the contract, however, resulted in a welfare loss for road users (both those using the motorway and those using the parallel route). However, our simulation shows that this could have been avoided by negotiating a greater reduction in tolls, while still guaranteeing welfare gains for taxpayers and for the concessionaire. Indeed, a toll reduction of between 44.1% and 46.3% would have left road users indifferent. Unfortunately, the general inability of citizens to organise themselves and to be better informed about the impact of such agreements play against their long-term interests. Although some road users may look at a reduction in tolls linked to the extension of the contract as advantageous, we have shown that in the long term they loss out.

It is hardly surprising, therefore, that governments have an interest in extending tolled motorway contracts to avoid the public expenditure associated with the management of these roads and the fall in their VAT revenues. This presumably explains why only one concession has ever been transferred back to the state in Spain, while all others have been subject to renegotiation. Likewise, political economy motives cannot be ignored, as incumbents have clear incentives to lower the regulated price of tolled motorways in order to imply a gain to current users (voters) although that welfare gain is only short term.

Finally, as a result of the renegotiation of concession contacts, taxpayers are better off, which means public finances are healthier. This, in turn, may lead to a general reduction in taxes or to higher expenditure to the benefit of the citizens. All in all, there is probably a transfer of welfare from motorway users to the rest of the taxpayers, something that could not happen with shadow tolls.

Currently, the contracts for the radial motorways providing access to Madrid, which were awarded in the early 2000s, are being reviewed, due to the precarious financial situation created by huge debt burdens, low demand and competition from free parallel motorways. All the indications are that they will shortly come under renegotiation. In this regard, this paper provides an empirical strategy for evaluating future renegotiations in terms of agents' welfare.

References

Albalate, D., 2014. The Privatisation and Nationalisation of European Roads: Success and failure in Public Private Partnerships. Cheltenham: Edward Elgar.

Albalate, D., 2011. Shifting death to their alternatives: The case of toll motorways. Journal of Transport Economics and Policy 45(3), 453-479.

Albalate, D., Bel, G., Fageda, X., 2009. Privatization and regulatory reform of toll motorways in Europe. Governance 22(2), 295-318.

Athias, L., Nuñez, A., 2008. Winner's curse in toll road concessions. Economic letters 101(3), 172-174.

Bain, R., 2009. Error and optimism bias in toll road traffic forecasts. Transportation, 36(5), 469-482.

Bel, G., 1999. Financiación de infraestructuras viarias: La economía política de los peajes. Papeles De Economía Española, 82, 123-139.

Bel, G., Fageda, X., 2005. Is a mixed funding model for the highway network sustainable over time? The Spanish case. Research in Transportation Economics, 15, 187-203.

Bel, G., Foote, J., 2009. Tolls, Terms, and Public Interest in Road Concessions Privatization: A Comparative Analysis of Recent Transaction in the USA and France. Transport Reviews 29(3), 397-413.

Engel, E., Fischer, R., Galetovic, A., 1996. Licitación de carreteras en Chile. Estudios Públicos, 61, 5-37.

Engel, E., Fischer, R., Galetovic, A., 1997. Highway franchising: pitfalls and opportunities. The American Economic Review, 87(2), 68-72.

Engel, E., Fischer, R., Galetovic, A., 2001. Least-present-value-of-revenue auctions and highway franchising. Journal of Political Economy, 109 (5), 993-1020.

Engel, E., Fischer, R., Galetovic, A., 2003b. Privatizing highways in Latin America: is it possible to fix what went wrong? Economía, Journal of the Latin American and Caribbean Economics Association 4(1), 129-164.

Engel, E. Fischer, R., Galetovic, A., 2006a. Privatizing highways in the United States. Review of Industrial Organization, 29(1-2), 27-53.

Guasch, J., 2004. Garanting and Renegotiating Infrastructure Concessions. Doing it Right. The World Banck, Washington.

Guasch, J., Laffont, J., Straub, S., 2008. Renegotiation of concession contracts in Latin America. Evidence from the water and transport sector. International Journal of Industrial Organitzation 26 (2), 421-442.

Kerf, M., Garay, R., Irwin, T., Levesque, C., Taylor, R., 1998. Concessions for infrastructure. A guide to their design and award. World Bank Technical paper 399.

Matas, A., Raymond, J., 2003. Demand elasticity on tolled motorways. Journal of Transportation and Statistics, 6(2), 91-108

Souto, G., 2001. Trabajo y capital en la evaluación pública de proyectos. Madrid, Instituto de Estudios Fiscales, Serie Investigaciones 6.

Chapter 4

Public Private Partnership Management Effects on Road Safety Outcomes

Public Private Partnerships (PPPs) have become common in providing high-quality infrastructure in many countries worldwide. One of the main reasons for PPP agreements is to improve efficiency and quality in the delivery of public services, as well as to boost investments for expensive projects. Despite PPPs having been particularly widespread in the case of the construction and rehabilitation of high-capacity road infrastructure, their impact in terms of road safety outcomes is still unexplored. This paper studies the effects of PPPs on road safety outcomes by taking advantage of the variety of management models provided in the Spanish highway network. Results based on a panel-data fixed-effects method show that the most relevant aspect influencing road safety outcomes is the quality of design of the road. However, we find strong evidence suggesting that privately operated highways perform better in terms of road safety outcomes than publicly operated highways, for roads with a similar quality of design.

Keywords: Public Private Partnership, highway, road safety, management.

JEL Codes: H23, I18, l33.

1. Introduction

Road accidents are among the main causes of death around the world. According to the World Health Organization (2015), more than 1.2 million people die every year on the roads, and for each person that dies there are at least 20 others that sustain nonfatal injuries, as a result of traffic crashes. Apart from the human suffering, the economic costs associated with these tragedies are high in terms of health spending, insurance costs, productivity losses and congestion costs. The last estimates of the European Commission (2010) calculate that 130 billion euros - approximately 2% of the GDP - are economic costs associated with road accidents. More recently, the International Road Assessment Program (2015) has found that the global economic cost of road deaths and serious injuries is about 1.8 trillion dollars per year in the world, an average of 3% of the GDP in each country.

There is a collective public interest in improving global road safety. Nonetheless, road transport remains as one of the most dangerous modes of transport. In 2015, in the European Union alone, the total number of fatalities from road accidents was 26,134, while from railways and airplanes the number of lives lost was just 27 and 150, respectively.[25] Improving road safety is linked to lower social and economic costs and more sustainable development. Therefore, multitudinous initiatives are currently being taken by transport authorities worldwide.

From 1990 to 2015 governments around the world have awarded more than 950 PPP road projects with a total amount of investment of 267,039 million dollars.[26] In many developed and developing countries, PPPs are an important and attractive alternative for financing and managing road highways (Engel et al., 2003b; Bel and Foote, 2009; Albalate, 2014). One of the most common strategies proposed by policy makers to reach better road safety outcomes has been to upgrade the quality of the roads. Nevertheless, public debt burden and fiscal stress have led governments to find ways of achieving better roads without compromising the state's accountability. The provision of better roads through public-private partnerships (PPPs) has become almost normal practice to circumvent budgetary restrictions (Hammami et al., 2006; Albalate et al., 2017). Thus, governments find an ally in the private sector to meet the challenge of providing new and better road infrastructure.

[25] Eurostat database. Data for 28 EU Member States.
[26] The World Bank database.

Another important argument for the implementation of PPPs has been to increase economic efficiency (Grimsey and Lewis, 2002; World Bank, 2012). Given that the private sector is profit-making, the lifecycle costs should be optimized. However, within the property rights theory of ownership based on incomplete contracting, it has been argued that although private management may improve productive performance it may harm the quality of services (Hart et al., 1997; Hart, 2003), and indirectly, the safety outcomes of the service delivered. Supporters of private management claim that the private sector can provide public services more efficiently than governments, but critics claim that private companies will prioritize economic revenues over the quality and safety of services. Empirical evidence of the productive performance of road investment, as between PPPs and traditional procurement, is limited and findings show mixed results (Blanc-Brude et al., 2009; Raisbek et al., 2010; Chasey et al., 2012).

However, other scholars argue that it is precisely the drive to improve the quality of services that brings about PPPs (Harris, 2004; Hodge and Greve, 2007). According to the European Commission (2003), the quality of services achieved under PPPs is better than traditional procurement due to the fact that the private sector introduces innovation in service delivery, promotes better integration of services, improves economies of scale and allows performance-based contracts. Nevertheless, there is a lack of empirical evidence of the relationship between quality and ownership or management models, particularly where road safety is concerned.

Indeed, an improved design and maintenance of roads would reduce accidents and provide users with more efficient mobility, comfort and lower vehicle operating costs (Burningham and Stankevich, 2005). Moreover, some practitioners suggest that there are fewer accidents on private roads than public roads (Samuel and Poole, 2000; Sisiopiku et al., 2006; Block, 2009), advocating for the road safety benefits of PPPs. Contrarily, others advise that private management can be more costly and might lead to problems with safety and quality (Kusnet, 2007). However, the effects of management on quality measured in road safety outcomes have not yet been deeply analyzed.

In this paper we aim to shed light on this gap by analyzing empirically the effects of management models (PPPs vs. public management) on road safety outcomes in Spain, where there is a mix of management models composed of publicly managed highways and those privately managed under PPP

agreements. We apply different count data models, within the framework of panel-data econometric techniques, in order to evaluate the role of management models on the determination of the number of accidents with victims and the number of victims (casualties).

The remainder of the article is organized as follows: Section 2 provides a literature review on PPPs and road safety. Section 3 defines the Spanish mixed model of highway management that allows us to compare both management models within the same network and countrywide experience. Section 4 provides the data and variables used and the empirical strategy employed. Results are presented in Section 5. In Section 6 we conclude.

2. Literature on Public-Private Partnerships and Road Safety

2.1 Public-Private Partnership: A Definition

A public-private partnership can be broadly defined as a contractual agreement between public administration and at least one private company, in which the private party is engaged to finance, build or rehabilitate and manage a project through a long-term contractual agreement until the contract expires and the asset returns to public ownership (Grimsey and Lewis, 2004).

However, there are several aspects to this concept that include some common features. Firstly, a PPP is a cooperative activity between the public and private sectors (Osborne, 2002; Van Ham and Koppenjan, 2001). Secondly, risks are shared between parties (HM Treasury, 2003; OECD, 2008). Thirdly, various tasks are bundled under the same contract (Grimsey and Lewis, 2004; Hodge et al., 2010). Fourthly, these contracts can take many forms[27] such as; build, operate and transfer (BOT), build, own, operate and transfer (BOOT), design, build, finance and operate (DBOT), and rehabilitate, operate and transfer (ROT) (GAO, 1999; World Bank, 2012). Fifthly, two types of infrastructure investment are available in PPP projects: greenfields and brownfields. Investing in a new infrastructure asset is considered as a greenfield

[27] Industrial organization requires that to be considered a PPP the bundling of construction and operation must be under the same contract (Martimort and Pouyet, 2008; Bennett and Iossa, 2006).

project and investing in an existing asset at the operational phase is a brownfield project. Greenfield assets have high levels of business, construction and demand risks, while brownfield investments are perceived to be the lowest-return and lowest-risk sector of infrastructure investment (Bitsch et al., 2010). Therefore, operational risk on brownfield projects should be smaller than in greenfield investment due to the asset having been working for some time.

2.2 Public-Private Partnerships and Road Safety Outcomes

Although the empirical literature has not explored the direct impact of PPPs on road safety, we can identify two strands of related literature. On the one hand, research on the role of tolls in producing traffic shift onto alternative roads (re-routing effects). On the other hand, research exploring the influence of the introduction of performance-based incentives in road management contracts.

2.2.1 Re-routing Effects and Road Safety

Re-routing literature provides evidence that road accidents are higher on roads that are alternatives to tolled highways, due to the fact that charging for the use of the better road may encourage too many drivers to choose alternative free minor roads, which are generally of poorer quality or not prepared to receive high amounts of traffic. This literature is connected to our work in the sense that PPPs are generally associated with user payments via tolls, even though other PPP models may involve shadow tolls, which are not charged to users but to taxpayers. Publicly operated highways might also charge tolls to users, as is common in the United States and was common in some European countries such as France, Italy and Portugal before the privatization of their networks.

One of the earliest works is Lyles et al. (1990). This study evaluates the crash frequency and crash rate of large trucks in Michigan. The most significant findings were that crash rates were five to seven times higher on lowest class roadways than those on the controlled access system. Similarly, a recent study, also for the US, by Swan and Belzer (2013), estimates the crash cost per vehicle mile traveled for trucks that diverted from the Ohio Turnpike to avoid paying tolls. Results show that crash costs are highest for the roads to which truck traffic was diverted.

In Europe we also find similar studies. Broughton and Gower (1998) analyzed the effects of motorway tolls on the number of accidents in the United Kingdom. Results show that a 10% diversion of motorway traffic from the toll motorways in Kent would increase the number of accidents in the entire county by about 3.5%. In this same line of research, Albalate (2011) tests whether charging for the use of highways might negatively affect road safety outcomes on the adjacent free roads. The author found that road accidents in Spain are higher on routes adjacent to toll motorways than those adjacent to free motorways, controlling for traffic and other potential determinants of road safety. And more recently, Baumgarten and Middelkamp (2015) analyzed the impact of the implementation of the German heavy good vehicle toll and the re-routing effects on road safety outcomes. Results of this study indicate that interurban toll charging causes traffic diversion, producing a negative impact on Germany's road safety outcomes.

Finally, at a national scale, we find the work by Albalate and Bel (2012), which investigates the relationship between different types of road quality and their impact on national safety outcomes in Europe. Their findings suggest that, distinguishing between free and tolled motorways, the former were associated with a statistically significant reduction in traffic fatalities, probably as a consequence of the re-routing effect.

2.2.2 Public-Private Partnership and Safety Incentives in Contracts

Some theoretical approaches to PPPs hold that the introduction of performance-based incentives in road management contracts may contribute to improving road safety outcomes (Grimsey and Lewis, 2007). However, empirical analyses of these effects are scarce and limited to few works.

This literature is based on the assumption that many aspects of improving road safety, for example pavement maintenance and renewal, safety emergency assistance, safety equipment, etc., can be introduced into the contract through an incentive mechanism.

As far as we know, empirical studies on this incentive scheme in road contracts can only be found for the case of Spain. By using a dataset with public and private highways in a cross-section setting for the year 2006, Rangel et al. (2012) found that there are more fatalities, injuries and accidents on highways without road safety incentives than on highways with incentives. Also, Rangel

et al. (2013) evaluated incentive schemes by using data only from private highways between 2007 and 2009, finding that road incentives are significant factors reducing the number of accidents and injuries but not decreasing the number of fatalities. More recently, Rangel and Vassallo (2015) expanded the previous dataset, including all types of highways - not only private but also public - confirming that there are more accidents on highways without incentives than those with incentives.[28]

Some of these papers included a variable controlling for the road management model. However, it was not the main focus of their analyses (see Rangel et al., 2012 and Rangel and Vassallo, 2015). These papers conclude that toll highways (privately managed) are safer than the second generation of public highways. However, in the case of Rangel et al. (2012) results indicated that the first generation of public highways, is safer than the second generation of public highways. This result was considered by the authors as an odd feature of their findings and, subsequently, it was reversed in Rangel and Vassallo (2015).

The contribution of this paper to the literature is twofold. Firstly, it differs from the previous research on re-routing by exploring the direct safety effect on the road managed by the private manager, and not on the adjacent alternative roads stressed by the diversion of traffic. Secondly, we provide a panel-data econometric estimation to explore the role of the management model on road safety outcomes, distinguishing by the quality of design of roads in a long panel-data fixed-effects model. Therefore, we separate the quality of road design into different tiers which allows us to make a more robust comparison between the private and public management models, avoiding the bias produced by the different engineering qualities of the infrastructure. Thus, our results should not be influenced by the construction design.

3. The Spanish Mixed Road Network

The highway network management in Spain is quite singular compared to most European countries. Spain has a long tradition of building and managing road highways through PPPs. However, since the end of the 80s different types of management can be found (Bel and Fageda, 2005; Albalate et al., 2009; Albalate, 2014). The first private highways were awarded in Spain at the end of the 60s.

[28] This paper dismisses the use of a panel-data specification arguing that spatial and temporal correlation problems were not expected in the sample analyzed.

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. The government opted for private funding and by the second half of the 70s more than 1,800 km of private highways were already constructed.

In the early 80s, the democratic transition and the oil crisis increased the financial expenses and construction costs, bringing the private highway expansion work to a halt. However, a large number of kilometers of the Spanish network was single and dual carriageways and the growth of the highway network was still necessary[29]. The new government that took office in 1982 and remained until 1996 − politically opposed to continued expansion of the highway network with private participation − approved the first program of public highways[30] and started to build the first generation of publicly managed free highways. However, this first generation of free highways was constructed by doubling existing carriageways[31]. The three main reasons for doubling were economics (to take advantage of the existing road), traffic flow (private highways had not solved the traffic congestion on the adjacent roads), and safety (highways are safer) (Sánchez et al., 2007). At the end of the 80s more than 2,000 km of first generation free highways were already constructed but the geometric design of the roads (road design) was inferior to that of private highways.

In 1993 the government terminated the first program of public highways although the expansion of the network continued to develop but without doubling the existing carriageways. In 1996 the government changed and interest in private financing of highways was renewed. From 1996 to 2006 more than 800 km of private highways were already awarded. Nevertheless, the government continued constructing public highways[32]. At the end of 2006 the Spanish highway network totaled around 9,700 km. Private operators managed 2,700 km and the public sector 7,000 km (2,000 km of which correspond to first

[29] See MOPU (1984).
[30] Within the Plan General de Carreteras 1984-1991.
[31] The first generation of publicly managed highways is the Spanish radials: A-1 Madrid-Burgos, A-2 Madrid-Zaragoza, A-3 Madrid-Alicante, A-4 Madrid-Badajoz and A-6 Madrid-Benavente.
[32] In 1999 the state modified the technical normative. See Order 2107/1999 of the 27th December (BOE, 27/12/1999).

generation public highways, and the remaining 5,000 km to the second generation).

The private sector also plays a significant role in the management of free highways under shadow toll financing schemes. At the end of the 1990s, the Spanish government evaluated the state of roads across the country and found a need for improvements in quality, accessibility and safety throughout the public highway network. The so-called first generation highways, mostly constructed during the 1980s by duplicating the existing conventional routes, displayed outdated technical and functional features that were obsolete under the latest construction, conservation and exploitation regulations. They required improvements to layout parameters, surface regularity and other features of the road surface and safety elements, all in order to reduce travel times and accidents. The investment needed to carry out large-scale improvements to homogenize the quality standards of the whole freeway network, including the re-conditioning of first generation highways, would have imposed a massive burden on public expenditure planning. So, the government and congress modified the administrative contracting rules, expanding the range of possible contracts, always with the goal of either deferring and/or limiting the payment from the treasury, or its impact on the budget calculations (Bellod, 2006; Benito and Montesinos, 2003).[33] As indicated by Tello (2008), technical advisor at the Transportation Ministry in Spain, private management of road maintenance allowed for the stipulation of quality standards in the contract terms, which were measurable by means of objective parameters and should result in a better quality of service.

The privatization was not targeted road by road, but was designed as a widespread, general freeway improvement plan, affecting the whole network of old radial highways (2,100 km), which, at the time, carried 17% of total road traffic in Spain. No variations were made to take account of differing potential profitability.

[33] Law 55/99, of December 29, introduced the form of the *"service contract for the management of highways, [...] by which the contractor is awarded the execution of actions to maintain these infrastructures in optimal road conditions for a period of up to twenty years, and [which] may be extended […] to the activities of conservation, adaptation, reform, initial modernization, replacement and major repair of the highway; all with the purpose of solving the problem of the inadequacy of the first generation highways to the current and more demanding road safety criteria*". These management options were further developed by law 13/2003 on public works concessions and law 30/2007 on public contracts.

In fact, most of the contractors needed assistance from the government in 2010 and 2011, a few years after privatization, due to financial distress that coincided with the economic crisis. This prevented completion of the privatization plan, leaving about 1,000 km of first generation freeways under public management. All ten contracts auctioned had been awarded to private corporations, so no road had to be run by the public sector due to a lack of interest from private companies.[34]

Nowadays, 24% of the total highway network is managed by private companies and 76% by the public sector. However, the first generation of public highways − 50% managed by private operator and 50% by the public sector − has inferior geometric design than the private motorways and the second generation of public highways. Table 1 shows the length of the Spanish highway (RCE) by road operator and quality of the geometric design of roads.

Table 1. Spanish highway composition by road operator and quality of road design

Operator	Kilometers	% of km
Public high	7566	67%
Public low	1054	9%
Total public	8620	76%
Private high	1717	15%
Private low	1042	9%
Total private	2759	24%
Total	11379	100%

As we can see in Table 1, 82% of Spanish highways have high construction quality: 67% managed by the public sector (public_h) and 15% by a private operator (private_h). High-quality public highways have separated carriageways for each direction of circulation, have limited access to neighboring properties, do not cross any other path and offer free access to road users. In contrast, high-quality private highways have different carriageways for each direction of circulation separated from each other, have no access to neighboring properties,

[34] In September 2012, an additional 49 km of public highways were transferred to private operators. However, in this study, we have not counted these 49 km as privately managed, because the data we analyzed are from 2008 to 2012.

do not cross any other path, are exclusively for car traffic and only offer access to users by a direct toll.

Of the 18% of highways that are classified as of low-quality of construction, half are publicly managed (public_l) and the other half by private operators (private_l). These low-quality highways have the same road design characteristics because both belong to the first generation of public highways which were constructed by doubling existing conventional carriageways. That being said, low-quality private highways have undergone some conditional improvements and rehabilitation works since their privatization at the end of 2007.

We choose to analyze the case of Spain because of the particular mixed model of management that allows for a comparison between private and public management models within the same national network. Thus, we are able to compare different forms of delivery with similar road designs. This allows us to better pinpoint the true effects of management on road safety performance.

4. Methods and Data

4.1 Methodology

The most common methodology for modeling road accidents is based on count models because the nature of accident occurrence is random, discrete, non-negative and does not follow a normal (Gaussian) distribution.[35] Different approaches have been applied to evaluating road safety determinants. Many different prediction models are available for estimating the number of accidents linked to a set of exogenous variables (see Lord and Mannering, 2010; Mannering and Bhat, 2014). Given the characteristics of the outcome variables described above, count-data regression models based on a Poisson or on a negative binomial distribution are the most commonly used.[36] Nevertheless, a strong restriction of the Poisson model is that the mean and the variance have to be equal. This is the so-called equidispersion assumption. Unfortunately, this

[35] Other common models contain crash modification functions that cannot be applied in our setting given that we lack information on highway design changes and infrastructure variables. Obtaining these types of data to conduct further research using these models may certainly give more insights for the interpretation of our results. Indeed, it would provide a better identification of the role of infrastructure and engineering design.

[36] If the distribution of counts contains a much larger than expected number of zeros, Zero Inflate models are more appropriate (Lord et al., 2005b).

assumption is often violated when variance exceeds the mean, which indicates overdispersion in the data. It is when count data display overdispersion that the negative binomial regression model is more appropriate (Miaou and Lum, 1993; Hadi et al., 1995; Abdel-Aty and Radwan, 2000; Lord, 2006). The negative binomial distribution allows for a more flexible modeling of the variance than the Poisson model and ensures the avoidance of biased standard errors and inefficient estimated coefficients.

Since the seminal paper of Hausman et al. (1984), panel count models have been applied in road safety analysis in order to correct for unobservable time-invariant heterogeneity. Poisson and negative binomial panel data have been used in both random effects and fixed effects alternatives (Noland, 2003; Chin and Quddud, 2003; Yaacob et al., 2011; Hosseinpour et al., 2014). The random-effects model assumes that the individual effects are uncorrelated with the independent variables. If this is the case, then the random-effects model is unbiased, consistent and more efficient than the fixed-effects model. If the unobserved individual heterogeneity is correlated with the exogenous variables, then the random-effects model will produce inconsistent estimates. In this case the fixed-effects model, which always provides consistent estimates – but is less efficient than the random-effects model - is the most reliable choice.

4.2 Model Choice

Our data on road accidents are collected in panel form (846 control stations followed for 5 years, from 2008 to 2012) and a simple pooled Poisson model is first employed as a benchmark model. In the Poisson model, the assumption of independent observations over individual control stations and across time is consistent with the strong assumption that the mean and the variance have to be equal. The Wald test and the Likelihood Ratio tests allows us to reject the null hypothesis of no overdispersion, thus we conduct a pooled negative binomial regression as a preferred model[37]. We assume that individual effects are independent across control stations for a given year but note that individual effects can be correlated over time for a given control station. For this reason, panel-data models should be more appropriate than pooled models. The Likelihood Ratio test is used to check whether the data are better modeled using

[37] The χ^2statistic of the Wald test rejects the null hypothesis with a p-value=0.000. The χ^2statistic of the LR test rejects the null hypothesis with a p-value=0.000.

a panel structure or a pooled estimator with constant overdispersion. Results corroborate the reasoning that a panel structure is more appropriate[38].

As described above, in order to consider differences across control stations, two approaches can be used: random effects and fixed effects. In this study, both panel random-effects and fixed-effects negative binomial regression models have been applied and compared. Because we have some unobserved time invariant characteristics of the infrastructure variables such as lane widths, road curvature, and intersections that may violate the strict exogeneity assumption required for random effects, the recommended model used must be fixed effects. Notwithstanding the above, we conduct the Hausman test and results allow us to reject the null hypothesis of no systematic differences between the two models. This is the same as confirming the correlation between unobserved heterogeneity and the regressors, which indicates that the conditional fixed-effects negative binomial model is the only one ensuring consistent results.

In spite of the suitability of the fixed-effects negative binomial model there have been two different formulations. Firstly, the conditional estimation of fixed-effects negative binomial model developed by Hausman et al. (1984). Secondly, the unconditional estimation of fixed-effects negative binomial model proposed by Allison and Waterman (2002) and Greene (2007). The main difference is that in the conditional fixed-effects negative binomial model, the fixed effects enter the model through the dispersion parameter rather than the conditional mean function adopted by unconditional estimation. The conditional fixed-effects modeling implies that the time invariant variable can coexist with the effects, therefore time invariant variables are not dropped out from the model. Because the main variable of interest in this study is *management*, which is time invariant, the appropriate estimator is the conditional fixed-effects negative binomial model. In addition, using the conditional fixed-effects estimator, the incidental parameters problem (panel level heterogeneity) is avoided because the likelihood function is conditioned for each observed panel outcome by the sum of the counts for that panel. Once we eliminate the panel level heterogeneity, applying usual asymptotic theory with fixed time, and observations tending to infinity, the conditional fixed-effects estimator is consistent.

[38] The χ^2 statistic of the LR test rejects the null hypothesis with a p-value=0.000.

In order to obtain empirically the effects of management on road safety in the Spanish highway network, the following reduced form equation is estimated, employing the conditional two-way fixed-effects negative binomial model:

$$Y_{it} = \alpha + \beta manage_i + \delta X_{it} + \mu_i + \gamma_t + \varepsilon_{it}$$

where the dependent variable Y_{it} is a count of accidents (acc_with) or victims (vic) in control station *i* and year *t*, α is the constant term in the model. The main variable in the estimation is $manage_i$ which identifies whether the highway is managed by the public administration or by a private manager. In a disaggregated model we substitute this variable with four other variables: high-quality public highway (public_h), low-quality public highway (public_l), high-quality private highway (private_h) or low-quality private highway (private_l). X_{it} is the vector of road safety standard determinants, μ_i is the control station-specific fixed effect from which we obtain the locally specific road safety data and γ_t is the year-specific fixed effect. Finally, ε_{it} is the error term. The subscripts *i* and *t* define the cross-section and the time dimension of our data, respectively.

In the equation the number of counts y_{it} is assumed to follow a negative binomial distribution with $\mathrm{E}(y_{it}) = \Theta_i \lambda_{it}$ and $\mathrm{var}(y_{it}) = (1 + \Theta_i)\Theta_i \lambda_{it}$ where $\lambda_{it} = \exp^{(X_{it}{}'\beta)}$ and $\Theta_i = \alpha_i / \phi_i$. As previously defined, α_i is the individual specific fixed effects and ϕ_i is the negative binomial overdispersion parameter which can vary across individual effects and can take any value. Nevertheless, to estimate the parameters for the fixed-effects negative binomial model, the overdispersion parameter ϕ_i has been dropped out for conditional maximum likelihood.[39]

Furthermore, we use the exposure variable $vehikm_{it}$ because it is known that traffic flow varies from one control station to another and the total annual vehicles per km traveled could affect the count.[40] This means that the outcome variable needs a rate which is just a count per unit of vehicles/km traveled. The negative binomial manages exposure variables by using natural logarithms to change the outcome variable from a rate into a count. The exposure variable is entered in the log link function as the natural logarithm and it is required to have

[39] See Cameron and Trivedi (2005).
[40] For example, a count of 15 annual number of accidents with victims out of 50 million of vehicles per km traveled is much smaller than a count of 15 out of 10.

a fixed coefficient equal to one. The coefficient of one allows turning the count into a rate.

4.3 Data and Variables

4.3.1 Data

This study draws on a dataset extracted from the Spanish traffic map database (Mapa de tráfico, 2012) published annually by the Spanish General Traffic Directorate. The database is generated from two different sources. Traffic data are supplied by the Ministry of Public Works. Road accidents data are provided by the Ministry of Homeland Affairs, responsible for road safety in Spain. Accidents data cover all reported accidents with at least one person injured, recording the number of injuries and number of deaths, at the moment that the accident occurs, in segments belonging to different road categories of the state road network (RCE). The Spanish RCE on traffic map 2012 is segmented in 4,788 homogeneous lengths of 5.44 km. In each segment there is a control station that records annual and historical information on accidents, injuries and fatalities, and traffic mix. Since we are merely interested on high-capacity roads, we avoid using data related to two undivided dual carriageway and single carriage roads. In order to avoid selection bias we considered interurban and urban segmented road stretches with and without accidents recorded. Therefore, a total of 4,234 highway control stations were extracted out of 5,528 from the 2008 to 2012 database. Control stations without complete information for safety outcomes and traffic flow were excluded. The traffic map database also includes information on infrastructure characteristics such as number of lanes.

4.3.2 Dependent Variables

The count dependent variables considered in this study are the annual number of accidents with victims (acc_with) and the annual number of victims (vic) recorded in each control station. The variable annual number of victims is the sum of the annual number of injuries and the annual number of fatalities. We aggregate injuries and fatalities in one variable because data on injuries and fatalities are recorded at the moment the accident occurs. If a victim does not immediately die, we cannot identify if she finally dies because of the accident.

Information on these variables has been obtained from the 2012 traffic map database.[41]

Table 2. Descriptive statistics of the dependent variables by operator and quality of road design

	acc_with					vic				
Operator	Obs.	Mean	Std. Dev.	Min	Max	Obs.	Mean	Std. Dev.	Min	Max
Public high	2592	19.54	37.05	0	344	2590	31.23	58.24	0	512
Public low	549	34.47	82.06	0	1498	548	52.62	82.01	0	691
Total public	3141	22.14	48.97	0	1498	3138	34.97	63.55	0	691
Privat high	729	7.87	13.04	0	133	729	13.24	21.41	0	175
Privat low	364	27.91	42.71	0	286	364	47.04	69.25	0	444
Total private	1093	14.54	28.44	0	286	1093	24.5	46.4	0	444
Total	4234	20.18	44.22	0	1498	4231	32.26	59.76	0	691

The main variable of interest in this study is management (manage), however as we are interested in estimating the true effects of management, a quality categorization of the geometric design of roads has been conducted. Of the total highway network 24% is managed by private companies and the remaining 76% by the public sector. However, the geometric design of roads differs. The variable management is introduced in the model as a binary variable that identifies whether the road is managed by a private manager (value 1), or under public management (value 0). This variable, once it is disaggregated to deal with the different quality of design, is substituted by four binary variables. The high-quality public highway (public_h), low-quality public highway (public_l), high-quality private highway (private_h) or low-quality private highway (private_l). All of these are dummy variables. Thus, we need to drop out one of them to avoid perfect collinearity, and coefficients must be interpreted with respect to the variable excluded from the model. All

[41] Note that all our dependent variables involve injuries and fatalities, because we want to avoid problems of under-reporting. Although they might still pertain, - which is a limitation that we can hardly solve – most accidents with victims are widely reported. Even in the case of less severe injuries, that could lead to under-reporting, we do not have any reason to believe there are differences in reporting by road management model, such as could bias our results.

information on these variables is obtained from the 2012 traffic map database and from the 2012 Spanish toll highways annual report. Also, we take advantage of the research conducted by Sánchez et al. (2007) to identify the low-quality public highways. Table 2 reports the descriptive statistics of the dependent variables by operator and quality of the road design.

4.3.3 Exogenous variables

Our empirical model of road safety determinants must build on the grounds of previous research. It is well known that personal income, traffic conditions, infrastructure features, weather conditions and road users' behavior might affect road accidents.

There has been significant interest on the relation between road accidents and traffic conditions such as traffic flows (Martin, 2002; Lord et al., 2005a; Anastasopoulos and Mannering, 2009), traffic mix (Albalate, 2011; Castillo-Manzano et al., 2016) and speed of driving (Nilsson, 2004; Pei et al., 2012; Quddus, 2013). On the one hand, most studies reveal a positive relationship between accidents and traffic flow and traffic mix (Wang et al., 2013). However, other studies found that heavy vehicles do not seem to be associated with poorer road safety outcomes (Albalate, 2011; Castillo-Manzano et al., 2016). Thus, our model will control the number of vehicles per km (vehi_km) and the percentage of heavy vehicles (heavy_vehi). The variable *vehi_km* is defined as vehi_km = total average annual daily traffic * length of segment * 365. The variable *heavy_vehi* is the percentage of heavy vehicles in the total average annual daily traffic. Both variables are obtained through data compiled in the 2012 traffic map database. Also, we include the average age of the vehicle fleet of the province (age_vehi). The variable *age_vehi* was elaborated from data provided by the Spanish General Traffic Directorate.

On the other hand, the impact of variation in speed on road safety has been widely investigated but results suggest that speed has heterogeneous effects on road safety (Wang et al., 2013; Imprialou et al., 2006) and no conclusive results are derived. Because we could not confirm this as a variable our model does not contribute to the debate on the role of speed.

Road design is another factor that needs to be taken into account when analyzing road safety. Several researchers have focused on analyzing the relationship between accidents and a variety of different features of the infrastructure such as lane widths, number of traffic lanes, median shoulder,

pavement, road curvature, intersections and signalization (Abdel-Aty and Radwan, 2000; Noland and Oh, 2004; Meuleners et al., 2008). In general terms, results conclude that the road's characteristics have a statistically significant impact on safety (Albalate et al., 2013; Wang et al., 2013). Thus, improvements in road infrastructure have a positive effect in protecting users (Pérez, 2006; Gomes and Cardoso, 2012). In order to control for infrastructure features we include the number of lanes and the type of road - depending on whether it is an urban road or interurban road. This is introduced by including the variable interurban, which is a dummy variable taking value 1 for control stations placed in interurban sections and 0 otherwise. This is the only physical feature that we can include because information on these aspects is very limited in the traffic map database.

Climate and weather conditions have also been important variables in analyses of road safety investigation. Most studies show that conditions such as rainfall affect accident outcomes (Eisenberg, 2004; Hermans et al., 2006; Caliendo et al., 2007). For this reason we include in our equation of determinants the annual number of rainy days. The variable *rainy* is the annual average number of rainy days by province. Data were provided by the Spanish State Meteorological Agency.

It is widely known that individual driving behavior is a crucial determinant of road accidents. Among others, alcohol consumption, speeding or non-use of seat belt cause more accidents and might increase their seriousness. Many analyses of the effectiveness of enforcement laws such us speed limits, legal limits of blood alcohol content and seat belt laws have been carried out in recent years (Loeb, 2001; Dee et al., 2005; Albalate, 2008). Results suggest that the impact of laws and regulations may depend on the driving population under examination (Albalate et al., 2013). We therefore include variables of demographic characteristics of the population as in the number of young people between 20-29 years old (*pop_20a29*) and the elderly population above 80 years old (*pop_>80)*. In addition, we include the number of liters of alcohol consumed per capita at home (*alcohol_pc)* to account for the risk of drunk driving.

We also include the GDP per capita in order to account for the importance of income as a determinant of road accidents.

Data for all of the socio-economic variables are desegregated by province except for the variable *alcohol_pc*, which is only available by autonomous community. The variable *GDP_pc* and the variables *pop_20a29* and *pop_>80*

were collected from the Spanish National Statistics Institute database. The variable *alcohol_pc* was obtained from the Spanish Ministry of Industry.[42]

Table 3 provides information for the descriptive statistics of all these control variables.

Table 3. Descriptive statistics of control variables

Variable	Units	Mean	Std. Dev.	Min	Max
interurban	Dummy	0.861994	0.344941	0	1
lanes	Number of lanes by control station	4.304.503	0.866894	3	8
heavy_vehi	Percentage of heavy vehicles from the total AADT by control station	1.493.672	8.619.115	0.934113	6.122.128
vehi_km	Total AADT * length of segment * 365 by control station	51800000	51300000	176718.4	3.14e+08
GDP_pc	Annual GDP per capita at current prices by province	21279.37	4.257.559	14763	37675
alcohol_pc	Annual liters alcohol consumption per capita inside of home by regions	235.958	3.577.236	15.62	34.91
age_vehi	Total average age vehicle fleets by province	1.152.345	1.002.196	909.857	1.423.427
pop_20a29	Total population driving age between 20 and 29-year-old by province	177262.2	223154.8	10134	934239
pop_>80	Total population driving age older than 80-year-old by province	64405.79	70338.2	8577	295942
rainy	Annual average number of rainy days by province	947.201	4.059.686	8	203.5

[42] All these controls are measured at provincial level due to a lack of information on the specific drivers using the road at each control station. Thus, we control for this factor using the indirect proxy of the values at provincial level.

As a result, our main equation is the following:[43]

$$Y_{it} = \alpha + \beta manage_i + \delta_1 interurban_{it} + \delta_2 lanes_{it} + \delta_3 heavy\_vehi_{it} + \delta_4 GDP\_pc_{it} + \delta_5 alcohol\_pc_{it} + \delta_6 age\_vehi_{it} + \delta_7 pop\_20a29_{it} + \delta_8 pop{>}80_{it} + \delta_9 rainy_{it} + \gamma_{10} year_{it} + \mu_i + \varepsilon_{it}$$

where, $interurban_{it}$ is a dummy variable with value one for highways belonging to interurban environment and vale 1 for those placed in urban areas; $lanes_{it}$ is the number of lanes for each segment; $heavy\_vehi_{it}$ is the percentage of heavy vehicles from the total AADT by control station; GDP_pc_{it} is the annual GDP per capita at current prices by province; $alcohol\_pc_{it}$: is the annual liters alcohol consumption per capita inside of home by regions; age_vehi_{it} is the average vehicle fleet age by provinces; pop_20a29_{it} is the total population driving age between 20 and 29 year old by province; $pop\_{>}80_{it}$: is the total population driving age older than 80 years old by provinces; $rainy_{it}$ is the annual average number of rainy days by province; μ_i is the control station fixed effects; γ_t: is the year-specific fixed effect and ε_{it} is the error term.

5. Results

In this section we present the effects of management models on two road safety outcomes: the annual number of accidents with victims (acc_with) and the annual number of victims (vic). We first estimate pooled count data in both Poisson and negative binomial models, after that we conduct panel negative binomial estimations with random effects and conditional fixed effects. Table 4 reports the coefficient estimates for the four models regressed for both dependent variables (acc_with and vic). A positive sign indicates an increase in the annual number of accidents with victims (acc_with) and the annual number of victims (vic), whereas a negative sign indicates a decrease. Recall that our preferred model is the conditional fixed-effects model.

[43] Note that fixed effects models may also account for those unobserved factors that do not change over time. This mitigates the problem of some possible omissions of variables we do not have in our database, such as infrastructure features or average speed, that are hardly likely to change, annually, on the same stretch of road.

Table 4. Regression models for accidents with victims and victims by road operator.

Independent variables	Dependent variable (**acc_with**)				Dependent variable (**vic**)			
	Poisson	NegBin	RENB	FENB	Poisson	NegBin	RENB	FENB
Constant	-11.82***	-10.65***	-14.06***	-17.32***	-11.87***	-10.12***	-12.76***	-14.82***
	(-0.11)	(-0.51)	(-0.65)	(-0.82)	(-0.08)	(-0.57)	(-0.61)	(-0.76)
manage	-0.41***	-0.22***	-0.43***	-0.71***	-0.34***	-0.14***	-0.43***	-0.60***
	(-9.8e-03)	(-0.04)	(-0.07)	(-0.09)	(-7.6e-03)	(-0.05)	(-0.06)	(-0.08)
interurban	-0.01	-0.22***	0.03	-0.13	0.02***	-0.13*	0.12	-0.22*
	(-8.9e-03)	(-0.06)	(-0.09)	(-0.12)	(-7.2e-03)	(-0.06)	(-0.09)	(-0.11)
lanes	0.06***	0.04**	0.14***	0.21***	0.05***	0.0424	0.118***	0.149***
	(-2.9e-03)	(-0.02)	(-0.03)	(-0.04)	(-0.0024)	(-0.02)	(-0.03)	(-0.04)
heavy_vehi	-5.0e-03***	3.7e-03	0.02***	0.02***	-4.2e-03***	3.2e-03	0.02***	0.02***
	(-5.6e-04)	(-2.4e-03)	(-2.6e-03)	(-3.0e-03)	(-4.4e-04)	(-2.7e-03)	(2.7e-03)	(-3.0e-03)
GDP_pc	4.7e-06***	1.0e-06	8.6e-06	2.3e-05**	3.5e-06***	-2.8e-06	-4.6e-07	6.9e-06
	(-1.5e-06)	(-6.6e-06)	(-9.0e-06)	(-1.1e-05)	(-1.1e-06)	(-7.3e-06)	(-8.3e-06)	(-1.0e-05)
alcohol_pc	-0.04***	-0.05***	-0.08***	-0.06***	-0.03***	-0.04***	-0.11***	-0.09***
	(-1.5e-03)	(-6.9e-03)	(-7.3e-03)	(-7.6e-03)	(-0.00118)	(-0.00767)	(-0.0076)	(-0.00826)
age_vehi	-0.20***	-0.26***	-0.16***	0.04	-0.17***	-0.27***	-0.22***	-0.08*
	(-7.5e-03)	(-0.03)	(-0.04)	(-0.05)	(-5.8e-03)	(-0.03)	(-0.03)	(-0.04)
pop_20a29	-7.4e-07***	-1.3e-06***	-7.4e-07***	-1.1e-06***	-3.8e-07***	-1.3e-06***	-7.5e-07**	-1.1e-06***
	(-6.7e-08)	(-4.5e-07)	(-2.7e-07)	(-3.2e-07)	(-5.3e-08)	(-4.9e-07)	(-3.1e-07)	(-3.4e-07)
pop_>80	3.7e-06***	5.3e-06***	1.3e-06	2.3e-07	2.3e-06***	5.1e-06***	1.7e-06*	1.2e-06
	(-1.9e-07)	(-1.3e-06)	(-8.2e-07)	(-9.1e-07)	(-1.5e-07)	(-1.5e-06)	(-9.0e-07)	(-9.8e-07)
rainy	-2.5e-04	-8.4e-04	3.1e-03***	5.2e-03***	3.8e-04***	-1.1e-03	1.3e-03	3.0e-03***
	(-1.5e-04)	(-7.3e-04)	(-8.7e-04)	(-1.0e-03)	(-1.2e-04)	(-8.0e-04)	(-8.5e-04)	(-9.9e-04)
ln(vehi_km)	1	1	1	1	1	1	1	1
ln_r	-	-	0.26***	-	-	-	0.07	-
			(-0.06)				(-0.06)	
Ln_s	-	-	1.44***	-	-	-	2.07***	-
			(-0.09)				(-0.11)	
lnalpha	-	0.21***	-	-	-	0.453***	-	-
		(-0.02)				(-0.0249)		
Observations	3918	3918	3918	3616	3916	3916	3916	3614
N. of groups	-	-	826	738	-	-	826	738
Log Likeli.	-37221	-13769	-13430	-9027	-55640	-15553	-15342	-10443

Note: Time dummies are not reported. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

As we can see in Table 4, the expected number of accidents and victims for the variable management (manage), is statistically significant and negative for all the models regressed. Private management is associated with a lower number of accidents and victims. However, this result could be biased if private management is more present in roads with high-quality design. Therefore, we disaggregate the management variable into three variables indicating the interaction between the management model and the quality of the road. Results of this analysis are reported in Table 5 for the four models regressed and for both dependent variables (acc_with and vic). The results associated with the variables related to management and quality must be interpreted with respect to the category excluded, to avoid perfect collinearity. In our case, the benchmark variable excluded is *public_h*.

Results show that the annual number of accidents with victims (acc_with) and the annual number of victims (vic) decrease when the quality of the road design is high. It means that highways with high-quality road design are safer than those with low-quality design, as expected. Thus, it is clear that beyond the management model, the quality of design is a major determinant of road safety. As a consequence, any comparison must take into account the homogeneity of quality of design to evaluate differences caused by the management model.

Interestingly, the annual number of accidents with victims (acc_with) and the annual number of victims (vic) on highways that have high-quality of design (private_h and public_h) is lower under private management. This is what the statistically significant and negative coefficient tells us about the comparison between the private high-quality road and the public high-quality road. This result is consistent in all models regressed, providing first evidence of the road safety benefits of PPPs. When considering the coefficients associated with the highways of low-quality design (private_l and public_l), we observe that the expected number of victims (vic) is larger with respect to the low-quality public road, as expected. However, note that the coefficient of the privately managed low-quality road is substantially smaller than the coefficient associated with the low-quality publicly operated road, for the number of victims. Thus, we confirm that given the same quality of design, PPPs have a better safety performance when measured in terms of casualties (injuries and deaths). This result is not sustained when we measure the safety outcomes via the number of accidents with victims, given that the coefficients we obtain with the conditional fixed-effects model are roughly the same for the private and for the public low-quality roads.

Table 5. Regression models for accidents with victims and victims on management by road operator and quality of the road design.

Independent variables	Dependent variable (**acc_with**)				Dependent variable (**vic**)			
	Poisson	NegBin	RENB	FENB	Poisson	NegBin	RENB	FENB
Constant	-12.79***	-10.84***	-15.92***	-19.11***	-12.79***	-10.15***	-14.82***	-16.68***
	(-0.11)	(-0.51)	(-0.65)	(-0.82)	(-0.08)	(-0.56)	(-0.63)	(-0.75)
private_h	-0.69***	-0.40***	-0.81***	-1.21***	-0.65***	-0.36***	-0.72***	-0.98***
	(-0.01)	(-0.05)	(-0.08)	(-0.11)	(-0.01)	(-0.06)	(-0.08)	(-0.10)
private_l	0.06***	0.14**	0.60***	0.86***	0.12***	0.24***	0.60***	0.74***
	(-0.01)	(-0.07)	(-0.10)	(-0.14)	(-0.01)	(-0.07)	(-0.09)	(-0.11)
public_l	0.35***	0.25***	0.75***	0.83***	0.29***	0.20***	1.11***	1.28***
	(-0.01)	(-0.05)	(-0.07)	(-0.10)	(-8.3e-03)	(-0.06)	(-0.07)	(-0.09)
interurban	-0.16***	-0.26***	-0.07	-0.25**	-0.10***	-0.14**	-0.02	-0.35***
	(-0.01)	(-0.06)	(-0.09)	(-0.13)	(-8.1e-03)	(-0.07)	(-0.09)	(-0.11)
lanes	0.02***	0.013	0.06**	0.08*	0.01***	4.0e-03	0.04	0.042
	(-3.1e-03)	(-0.02)	(-0.03)	(-0.04)	(-2.5e-03)	(-0.02)	(-0.03)	(-0.04)
heavy_vehi	-9.5e-03***	-2.4e-03	0.01***	0.01***	-9.1e-03***	-3.1e-03	0.01***	0.01***
	(-5.7e-04)	(-2.5e-03)	(-2.7e-03)	(-3.1e-03)	(-4.5e-04)	(-2.7e-03)	(-2.8e-03)	(-3.1e-03)
GDP_pc	1.0e-05***	1.0e-05	3.4e-05***	4.9e-05***	1.0e-05***	6.7e-06	2.6e-05***	3.5e-05***
	(-1.5e-06)	(-6.6e-06)	(-9.1e-06)	(-1.1e-05)	(-1.2e-06)	(-7.3e-06)	(-8.5e-06)	(-1.0e-05)
alcohol_pc	-0.03***	-0.04***	-0.0728***	-0.06***	-0.02***	-0.04***	-0.09***	-0.07***
	(-1.5e-03)	(-6.8e-03)	(-7.0e-03)	(-7.3e-03)	(-1.2e-03)	(-7.5e-03)	(-7.4e-03)	(-7.8e-03)
age_vehi	-0.14***	-0.25***	-0.05	0.16***	-0.12***	-0.27***	-0.12***	0.014
	(-7.5e-03)	(-0.03)	(-0.04)	(-0.05)	(-5.8e-03)	(-0.03)	(-0.03)	(-0.04)
pop_20a29	-1.1e-06***	-1.6e-06***	-6.6e-07***	-8.5e-07***	-7.7e-07***	-1.6e-06***	-8.9e-07***	-1.0e-06***
	(-6.7e-08)	(-4.5e-07)	(-2.5e-07)	(-2.8e-07)	(-5.3e-08)	(-5.0e-07)	(-2.8e-07)	(-3.0e-07)
pop_>80	4.5e-06***	5.7e-06***	9.3e-07	9.3e-08	3.1e-06***	5.5e-06***	1.4e-06*	9.4e-07
	(-1.9e-07)	(-1.3e-06)	(-7.5e-07)	(-8.1e-07)	(-1.5e-07)	(-1.5e-06)	(-8.1e-07)	(-8.5e-07)
rainy	9.4e-04***	-3.7e-04	4.8e-03***	6.5e-03***	1.5e-03***	-7.6e-04	3.4e-03***	4.8e-03***
	(-1.6e-04)	(-7.2e-04)	(-8.6e-04)	(-9.9e-04)	(-1.2e-04)	(-7.9e-04)	(-8.6e-04)	(-9.6e-04)
ln(vehikm)	1	1	1	1	1	1	1	1
ln_r	-	-	0.27***	-	-	-	0.047	-
			(-0.06)				(-0.06)	
ln_s	-	-	1.41***	-	-	-	1.93***	-
			(-0.08)				(-0.10)	
lnalpha	-	0.18***	-	-	-	0.43***	-	-
		(-0.02)				-0.02		
Observations	3918	3918	3918	3616	3916	3916	3916	3614
N. of groups	-	-	826	738	-	-	826	738
Log Likeli.	-35897	-13739	-13320	-8917	-53606	-15527	-15186	-10292

Note: Time dummies are not reported. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Note, however, that one could argue that our results on private management might be skewed by the context of a privatization program that took place in 2008, on a set of 1,000 km of the first generation of freeways. A potential bias would arise from the infrastructure quality jump that could be pre-supposed with the rehabilitation of these roads. If these roads were performing poorly before privatization and received an investment boost that could significantly change their safety outcomes – statistically linked to private management in our model – our results on private management models could be biased. In order to check whether our results were skewed by this specific rehabilitation plan we ran our models again without these roads. Interestingly, our results point in the same direction, with or without these roads in the sample. Moreover, we realized that the coefficients for private management appear to be larger (in absolute terms) without these privatized roads. This means that without including the privatized roads the safety advantage of private management is even higher. If a bias did exist due to the rehabilitation plan, we would find lower coefficients (in absolute terms) without these roads. However, our evidence reveals the opposite. When we split the management models by the different quality and management models, the coefficients and their statistical significance are pretty much the same, with or without privatized highways in the sample. Table 6 and Table 7 summarizes the selected results for the management coefficients for this robustness check.[44]

Table 6. Robustness check. Sample without privatized highways. Selected Results.

Independent variables	Dependent variable (**acc_with**)				Dependent variable (**vic**)			
	Poisson	NegBin	RENB	FENB	Poisson	NegBin	RENB	FENB
manage	-0.76***	-0.44***	-0.93***	-1.40***	-0.70***	-0.38***	-0.85***	-1.20***
	(0.01)	(0.06)	(0.08)	(0.11)	(0.01)	(0.06)	(0.08)	(0.10)
Observations	3592	3592	3592	3313	3590	3590	3590	3311
N. of groups	-	-	753	674	-	-	753	674
Log Likeli.	-33805	-12419	-12155	-8164	-49074	-13995	-13834	-9411

Note: Other Covariates are not reported but were included in the regression models. Only coefficients for management related variables. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

[44] We also computed two sample t-tests of mean differences between groups of publicly managed roads before privatization in order to check whether roads privatized were precisely the ones performing worse before privatization. Our results for the two years before privatization indicate that mean differences in safety outcomes between privatized and never privatized highway was not statistically significant.

Table 7. Robustness checks. Sample without privatized highways. Selected Results.

Independent variables	Dependent Variable (**acc_with**)				Dependent Variable (**vic**)			
	Poisson	NegBin	RENB	FENB	Poisson	NegBin	RENB	FENB
private_h	-0.66***	-0.40***	-0.76***	-1.19***	-0.62***	-0.358***	-0.67***	-0.94***
	(0.01)	(0.06)	(0.08)	(0.11)	(0.01)	(0.0663)	(0.08)	(0.10)
public_l	0.33***	0.23***	0.71***	0.81***	0.26***	0.191***	1.04***	1.26***
	(0.01)	(0.06)	(0.07)	(0.10)	(8.5e-03)	(0.06)	(0.07)	(0.09)
Observations	3592	3592	3592	3313	3590	3590	3590	3311
N. of groups	-	-	753	674	-	-	753	674
Log Likeli.	-33323	-12412	-12113	-8134	-48584	-13991	-13745	-9333

Note: Other covariates are not reported but were included in the regression models. Only coefficients for management related variables. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Once we have described the effects of the core variable, we proceed to interpret the coefficients of the rest of the control variables. Relating to infrastructure characteristics, the number of accidents and victims decreases when the road highway is placed on the interurban environment (interurban). However, the more lanes the road highway has (lanes), the more accidents and victims are found. This effect is in line with Abdel-Aty and Radwan (2000) and Noland and Oh (2004). A large percentage of heavy vehicles (heavy_vehi) is related to more accidents and victims. This result may be explained by the fact that even though the average speed drops with more presence of heavy vehicles, trucks slow down the flow and safe distances are less respected. In the case of sudden braking the collision probability increases and as trucks are heavier than domestic vehicles the probability of victims also increases. This effect is in line with Jovanis and Chang (1986). The coefficient of the variable GDP per capita is positive and statistically significant in almost all the models reported. The number of accidents and victims increases in provinces with more GDP per capita suggesting that people who live in provinces that are richer are more risk prone because greater income is generally associated with more trips and movements. Accidents and victims decrease with the annual liters of alcohol consumption per capita inside the home (alcohol_pc). This result is counterintuitive because it is expected that regions with greater alcohol consumption have more accidents. However, the coefficient of *alcohol_pc* is negative and statistically significant in all models regressed. This result may be related to the fact that the variable of alcohol consumption is specifically in the home. People who drink more inside the home may be more concerned about the dangers of alcohol impaired driving and may not take the same risks of

drunk-driving. Unfortunately, we were unable to introduce a variable capturing the alcohol consumption outside the home. The variable *age_vehi* shows an unstable behaviour: in some models it is statistically significant and positive, while in other model regressions it is statistically significant and negative. These results make it difficult to obtain clear conclusions, however there is significant evidence that the average age of vehicle fleets has some effect on road safety outcomes.

The demographic variables *pop_20a29* and *pop_>80* have been employed as a proxy for people's driving behavior. The number of accidents and victims decreases in provinces with a young driving population but increases with an older cohort of population. The coefficient associated with the variable *rainy* is positive and statistically significant. The number of accidents and victims increases in control stations where more rainy days are registered. This effect is in line with Hermans et al. (2006) and Caliendo et al. (2007).

6. Conclusions

In this paper we provide the first evidence of the role of road management models on road safety outcomes for a national highway network. After confirming that highways with-high quality road design are safer than those with low-quality road design, disregarding the management model and realizing that a true comparison between management models must consider homogeneous design quality, we found heterogeneous effects depending on whether the management of the road was private or public. Our results show that privately operated roads perform better in terms of road safety outcomes than publicly operated roads for the high-quality standard (road design) highways. The annual number of accidents with victims and the annual number of victims on highways is lower under public-private partnerships. Results are also favorable for private operators on highways with low-quality road design, but only in the case of the number of victims. The differences between road management models in low-quality roads is not statistically significant for the number of accidents, so we should be cautious about the implications of our results on the superiority of private management for this kind of road.

These findings are important in several ways. Firstly, in order to promote road safety the infrastructure should support high road design characteristics. The design and initial construction are crucial because once the road is built it

is very costly and difficult to modify the geometrical design. Thus, our results indicate that beyond the road management model, the most important factor in determining road safety outcomes is the quality standard of the road infrastructure.

Secondly, for the same quality standard, we found that private highways show better road safety outcomes. It is necessary to understand the reasons behind this fact. That may feed an interesting line of future research. On the one hand, it may imply that private operators take actions or decisions that favor road safety, which may provide arguments for going private. On the other hand, public operators might learn from the better actions and performance of private operators in order to improve their outcomes, without going private. In any case, further research should focus on the management differences of private and public operators to better understand these safety implications.

Although more investigation is needed, we offer two possible explanations for the differences between private and public models: infrastructure features on the one hand, and incentives and regulation on the other. Firstly, part of the free highway network was constructed by duplicating conventional roads - implying that certain stretches present, for example, improper curvature radius, camber and slopes - while most private highways were greenfield projects, unlinked to previous infrastructure. This could explain part of the difference we find between public and private management models and would be specific to the case study, so we should be cautious about generalizing these results.

Secondly, all PPP highways in Spain contend with demand risk. PPPs are therefore transferring traffic risk to the private operator, whose incentive to provide good quality standards is to attract users. This incentive is less pressing in the case of public roads, because the public sector has a large portfolio of projects, can better diversify risk and does not face the prospect of bankruptcy. In addition, regulations monitoring private operators increase the incentive to offer high-quality standards. Recent private motorways (tolled and free) must work within a strict regulatory framework that involves quality measurement, for instance, the firm's transparency, implementation of policies to reduce the accident or congestion rates, treatment of winter viability, reduction of queues at tolls and availability of real-time information, among others. It is often remarked that private ownership and regulation are synonymous. The privatization of motorways is usually associated with more and increasingly sophisticated regulations, to keep control. Conversely, if the owner is the public

sector there is less need for regulation given that the state has more leeway for arbitrariness (Albalate et al. 2009). Concession contracts establish a set of indicators of status and quality of service that oblige the concessionaire to guarantee the maintenance of the infrastructure in the most optimal conditions for the user. Also, in the bidding process, an important part of the valuation given to candidates is derived from the technical, functional and static characteristics of roads. Private management of roads allows for the stipulation of quality standards incorporated in the contract terms and measurable by means of objective parameters, resulting in a better quality of service.

References

Abdel-Aty, M.A., Radwan, A.E., 2000. Modelling Traffic Accident Occurrence and Involvement. Accident Analysis and Prevention 32(5), 633-642.

Albalate, D., 2014. The Privatisation and Nationalisation of European Roads: Success and failure in Public Private Partnerships. Cheltenham: Edward Elgar.

Albalate, D., 2008. Lowering blood alcohol content levels to save lives: the European experience. Journal of Policy Analysis and Management 27(1), 20-39.

Albalate, D., 2011. Shifting death to their alternatives: The case of toll motorways. Journal of Transport Economics and Policy 45(3), 453-479.

Albalate, D., Bel, G., 2012. Motorways, tolls and road safety: Evidence from Europe. Journal of Spanish Economic Association 3(4), 457-473.

Albalate, D., Bel, G., Fageda, X., 2009. Privatization and regulatory reform of toll motorways in Europe. Governance 22(2), 295-318.

Albalate, D., Bel, G., Geddes, R.R., 2017. How much vertical integration? Contractual Choice and Public-Private Partnerships in the United States. Review of Industrial Organization 51, 25-42.

Albalate, D., Fernández, L., Yarygina, A., 2013. The road against fatalities: Infrastructure spending vs. regulation??. Accident Analysis and Prevention 59, 227-239.

Allison, P.D., Waterman, R., 2002. Fixed effects negative binomial regression models. Sociological Methodology 32(1), 247-265.

Anastasopoulos, P.C., Mannering, F.L., 2009. A note on modeling vehicle accident frequencies with random-parameters count models. Accident Analysis and Prevention 41(1), 153-159.

Baumgarten, P., Middelkamp, J., 2015. On interurban road pricing schemes and the impacts of traffic diversion on road safety in Germany: Empirical findings and implications. European Journal of Transport and Infrastructure Research 15(2), 147-162.

Bel, G., Fageda, X., 2005. Is a mixed funding model for the highway network sustainable over time? The Spanish case. Research in Transportation Economics, 15, 187-203.

Bel, G., Foote, J., 2009. Tolls, Terms, and Public Interest in Road Concessions Privatization: A Comparative Analysis of Recent Transaction in the USA and France. Transport Reviews 29(3), 397-413.

Bellod, J.L., 2006. Financiación privada de infraestructuras: El caso de la Autovía del Noroeste. Presupuesto y Gasto Público 44(2006), 133-144.

Benito, B., Montesinos, V., 2003. Análisis de la Financiación ¿Privada? de Infraestructuras. Revista Valenciana de Economía y Hacienda 9(2003), 9-28.

Bennett, J., Iossa, E., 2006. Building and Managing Facilities for Public Services. Journal of Public Economics 90(10-11), 2143-2160.

Bitsch, F., Buchner, A., Kaserer, C., 2010. Risk, Return and Cash Flow Characteristics of Infrastructure Fund Investments. EIB Papers, 15(1), 106-136.

Blanc-Brude, F., Goldsmith, H., Välilä, T., 2009. A Comparison of Construction Contract Prices for Traditionally Procured Roads and Public–Private Partnerships. Review of Industrial Organization 35(1-2), 19-40.

Block, W., 2009. The Privatization of Roads and Highways: Human and Economic Factors. Ludwig von Mises Institute

Broughton, J., Gower, P., 1998. The likely effects of motorways tolling on accident risk-phase 2. TRL Report TRL 352, Transport Research Laboratory, Crowthorne.

Broughton, J., Gower, P., 1998. The likely effects of motorways tolling on accident risk-phase 2. TRL Report TRL 352, Transport Research Laboratory, Crowthorne.

Burningham, S., Stankevich, N., 2005. Why road maintenance is important and how to get it done. The World Bank, Washington, DC. Transport Note (TRN-4).

Caliendo, C., Guida, M., Parisi, A., 2007. A crash-prediction model for multilane roads. Accident. Analysis and Prevention 39(4), 657-670.

Cameron, A.C., Trivedi, P.K., 2005. Microeconometrics. Methods and Application. Cambridge: Cambridge University Press.

Castillo-Manzano, J.I., Castro-Nuño, M., Fageda, X., 2016. Exploring the relationship between truck load capacity and traffic accidents in the European Union. Transportation Research Part E 88, 94-109.

Chasey, A.D., Maddex, W.E., Bansal, A., 2012. Comparison of public-private partnerships and traditional procurement methods in North American highway construction. Transportation Research Record: Journal of the Transportation Research Board 2268(1), 26-32.

Chin H.C., Quddus, M.A., 2003. Applying the random effect negative binomial model to examine traffic accident occurrence at signalized intersections. Accident Analysis and Prevention 35(2), 253-259.

Dee, T.S., Grabowski, D.C., Morrisey, M.A., 2005. Graduated driver licensing and teen traffic fatalities. Journal of Health Economics 24(3), 571-589.

Eisenberg, D., 2004. The mixed effects of precipitation on traffic crashes. Accident analysis and prevention 36(4), 637-647.

Engel, E., Fischer, R., Galetovic, A., 2003b. Privatizing highways in Latin America: is it possible to fix what went wrong? Economía, Journal of the Latin American and Caribbean Economics Association 4(1), 129-164.

European Commission, 2003. Guidelines for Successful Public-Private Partnership. European Commission.

European Commission, 2010. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Towards a European

road safety area: policy orientations on road safety 2011-2020. European Commission.

GAO, 1999. Public-Private Partnerships. Terms Related to Building and Facility Partnerships. United States General Accounting Office.

Gomes, S.V., Cardoso, J.L., 2012. Safety effects of low-cost engineering measures. An observational study in a Portuguese multilane road. Accident Analysis and Prevention 48, 346-352.

Greene, W., 2007. Functional form and heterogeneity in models for count data. Foundations and Trends in Econometrics 1(2), 113-218.

Grimsey, D., Lewis, M.K., 2002. Evaluating the risks of public private partnerships for infrastructure projects. International Journal of Project Management 20(2), 107-118.

Grimsey, D., Lewis, M.K., 2004. Public private partnerships: The worldwide revolution in infrastructure provision and project finance. Cheltenham: Edward Elgar.

Grimsey, D., Lewis, M.K., 2007. Public private partnerships: The worldwide revolution in infrastructure provision and project finance. Cheltenham: Edward Elgar.

Hadi, M., Aruldhas, J., Chow, L.F., Wattleworth, J., 1995. Estimating safety effects of cross-section design for various highway types using negative binomial regression. Transportation Research Record 1500, 169-177.

Hammami, M., Ruhashyankiko, J.F., Yehoue, E.B., 2006. Determinants of public-private partnerships in infrastructure. International Monetary Fund, working paper.

Harris, S., 2004. Public private partnerships: delivering better infrastructure services. Inter-American Development Bank, working paper.

Hart, O., 2003. Incomplete contracts and public ownership: Remarks, and an application to public private partnerships. The Economic Journal, 113(486), 69-76.

Hart, O., Shleifer, A., Vishny, R.W., 1997. The Proper Scope of Government: Theory and an Application to prisons. The Quarterly Journal of Economics 112(4), 1127-1162.

Hausman, J.A., Hall, B.H., Griliches, Z., 1984. Econometric Models for Count Data with an Application to the patents-R&D Relationship. Econometrica 52(4), 909-938.

Hermans, E., Brijs, T., Stiers, T., Offermans, C., 2006. The impact of weather conditions on road safety investigated on an hourly basis. In: Proceedings of the 85thAnnual meeting of the Transportation Research Board. Washington, D.C, 1-16.

HM Treasury, 2003. PFI: meeting the investment challenge. HM Treasury.

Hodge, G.A., Greve, C., 2007. Public–Private Partnerships: An International Performance Review. Public Administration Review 67(3), 545-558.

Hodge, G.A., Greve, C., Boardman, A.E., 2010. Introduction: the PPP phenomenon and its evaluation. In: Hodge, G.A; Greve, C; Boardman, A.E. (Eds.), International Handbook of Public-Private Partnerships. Cheltenham: Edward Elgar, 3-16.

Hosseinpour, M., Yahaya, A.S., Sadullah, A.F., 2014. Exploring the effects of roadway characteristics on the frequency and severity of head-on crashes: Case studies from Malaysian Federal Roads. Accident Analysis and Prevention 62, 209-222.

Imprialou, M.I.M., Quddus, M., Pitfield, D.E., Lord, D., 2016. Re-visiting crash–speed relationships: A new perspective in crash modelling. Accident Analysis and Prevention 86, 173-185.

International Road Assessment Program, 2015. Vaccines for roads. International Road Assessment Program.

Jovanis, P.P., Chang, H-L., 1986. Modeling the relationship of accidents to miles traveled. Transportation Research Record 1068, 42-51.

Kusnet, D., 2007. Highway Robbery II. The Many Problems with Outsourcing Design, Engineering, Inspection & Supervision of Federally-Funded Transportation Projects: Increased Costs, reduced Quality & Safety, and Little Accountability to the Public. National Association of State Highway and Transportation Unions, 1-38.

Loeb, P.D., 2001. The effectiveness of seat belt legislation in reducing driver involved injury rates in Maryland. Transportation Research Part E 37(4), 297-310.

Lord, D., 2006. Modelling motor vehicle crashes using Poisson-gamma models: Examining the effects of low sample mean values and small sample size on the estimation of the fixed dispersion parameter. Accident Analysis and Prevention 38(4), 751-766.

Lord, D., Manar, A., Vizioli, A., 2005a. Modeling crash-flow-density and crash-flow-V/C ratio relationships for rural and urban freeway segments. Accident Analysis and Prevention 37(1), 185-199.

Lord, D., Mannering, F., 2010. The statistical analysis of crash-frequency data: a review and assessment of methodological alternatives. Transportation Research Part A 44(5), 291-305.

Lord, D., Washington, P., Ivan, J.N., 2005b. Poisson, Poisson-gamma and zero-inflated regression models of motor vehicle crashes: balancing statistical fit and theory. Accident Analysis and Prevention 37(1), 35-46.

Lyles, R.W., Stamatiadis, P., Blower, D., Campbell K., 1990. The Michigan heavy truck study – Final Report. College of Engineering, Michigan State University.

Mannering, F.L., Bhat, C.R., 2014. Analytic methods in accident research: Methodological frontier and future directions. Analytic Methods in Accident Research 1, 1-22.

Martimort, D., Pouyet, J., 2008. To build or not to build: Normative and positive theories of public-private partnerships. International Journal of Industrial Organization 26(2), 393-411.

Martin, J., 2002. Relationship between crash rate and hourly traffic flow on interurban motorways. Accident Analysis and Prevention 34 (5), 619–629.

Meuleners, H.M., Hendrie, D., Lee, A.H., Legge, M.G., 2008. Effectiveness of the Black Spot Programs in Western Australia. Accident Analysis and Prevention 40(3), 1211-1216.

Miaou, S.P., Lum, H., 1993. Modeling vehicle accidents and highway geometric design relationships. Accident Analysis and Prevention 25(6), 689-709.

MOPU, 1984. Plan General de Carreteras 1984-91. Dirección General de Carreteras del Ministerio de Obras Públicas y Urbanismo.

Nilsson, G., 2004. Traffic Safety Dimensions and the Power Model to Describe the Effect of Speed on Safety. Bulletin, 221. Lund Institute of Technology, Lund.

Noland, R.B., 2003. Traffic fatalities and injuries: the effect of changes in infrastructure and other trends. Accident Analysis and Prevention 35(4), 599-611.

Noland, R.B., Oh, L., 2004. The effect of infrastructure and demographic change on traffic-related fatalities and crashes: a case study of Illinois county-level data. Accident Analysis and Prevention 36(4), 525-532.

OECD, 2008. Public-Private Partnerships: In Pursuit of Risk Sharing and Value for money. Organization for Economic Cooperation and Development.

Osborne, S., 2002. Public-private partnerships: Theory and practice in international perspective. Routledge.

Pei, X., Wong, S.C., Sze, N.N., 2012. The roles of exposure and speed in road safety analysis. Accident Analysis and Prevention 48, 464-471.

PEIT, 2005. Plan Estratégico de Infraestructuras y Transporte. Ministerio de Fomento.

Pérez, I., 2006. Safety impact of engineering treatments on undivided rural roads. Accident Analysis and Prevention 38(1), 192-200.

Quddus, M., 2013. Exploring the relationship between average speed, speed variation, and accident rates using spatial statistical models and GIS. Journal of Transportation .Safety and Security 5(1), 27-45.

Raisbeck, P., Duffield, C., Xu, M., 2010. Comparative performance of PPPs and traditional procurement in Australia. Construction Management and Economics, 28(4), 345-359.

Rangel, T., Vassallo, J.M., 2015. Modeling the effect of contractual incentives on road safety performance. Transport Policy 40, 17-23.

Rangel, T., Vassallo, J.M., Arenas, B., 2012. Effectiveness of safety-based incentives in Public Private Partnerships: Evidence from the case of Spain. Transportation Research Part A 46(8), 1166-1176.

Rangel, T., Vassallo, J.M., Herraiz, I., 2013. The influence of economic incentives linked to road safety indicators on accidents: The case of toll concessions in Spain. Accident Analysis and Prevention 59, 529-536.

Samuel, P., Poole, R., 2000. Putting Customers in the Driver's Seat: The Case for Tolls. Policy Study, 274. Reason Public Policy Institute.

Sánchez, A., Vassallo, J.M., Castroman, A., Delgado, C., 2007. Nuevo modelo de gestión concesional en autovías de primera generación. Estudios de Construcción y Transporte 106, 157-178.

Sisiopiku, V.P., Waid, J.C., Rizk, T., McLeod, R., Robbins, W., 2006. Alternate Financing Sources for Alabama Highways. University Transportation Center for Alabama.

Swan, P.F., Belzer, M.H., 2013. Tolling and economic efficiency: do the pecuniary benefits exceed the safety costs?. Public Works Management and Policy 18(2), 167-184.

Tello, C., 2008. Modelos aplicados de colaboración público-privada por la Administración Pública: Experiencias en la Administración General del Estado. Revista Española de Control Externo, 10(28), 65-88.

Van Ham, H., Koppenjan, J., 2001. Building public–private partnerships: Assessing and managing risks in port development. Public Management Review 4(1), 593–616.

Wang, C., Quddus, M.A., Ison, S.G., 2013. The effect of traffic and road characteristics on road safety: A review and future research direction. Safety science 57, 264-275.

World Bank, 2012. Public-Private Partnerships reference guide. The World Bank.

World Health Organization, 2015. Global status report on road safety 2015. World Health Organization.

Yaacob, W.F.W., Lazim, M.A., Wah, Y.B., 2011. Applying Fixed Effects Panel Count Model to Examine Road Accident Occurrence. Journal of Applied Sciences 11(7), 1185-1191.

Chapter 5

Conclusions and Policy Implications

Taking Spain's experience as a framework for analysis, in this thesis we have examined various aspects affecting public-private partnerships in the high-capacity road infrastructure sector. Spain is a good context for analysis given its pioneering experience in the sector, the way in which the regulatory framework has been developed and its coexistence with traditional public provision since the late 1980s. Therefore, the three different approaches conducted in this thesis to analyze road infrastructure PPPs should be helpful not only to Spanish policy makers but also to governments, practitioners and scholars from other countries interested in road PPP programs.

Thanks to the exhaustive review of international experiences carried out in the first part of chapter 2, we can draw some conclusions of general interest on how the distribution and mitigation of risks in public-private partnership contracts have been carried out in the different countries analyzed. The exhaustive assessment and analysis of the concession contracts and laws carried out in the context of the country's political and macroeconomic environment allows us to draw some lessons for the improvement of these processes.

A first conclusion is that state guarantees act as a risk mitigation mechanism when the institutional environment is unstable. At times of heightened macroeconomic uncertainty, it is more difficult to attract private participation, especially from abroad given the economic uncertainty, and risk premiums therefore increase. A clear example of this situation can be seen in Spain's entry into the European Union. Admission into the European Union reduced economic instability and consequently financial risks and risk premium. Spain eliminated the need to establish state guarantees such as exchange rate insurance and subsequently debt endorsement. Another example is found in the case of Poland. Before joining the European Union, funding and judicial security mechanisms in Poland prevented the extension of public-private partnerships. With entry into the European Union, state guarantees were reduced, transferring risks previously borne by the public sector to the private partner.

A second conclusion is that in a situation of macroeconomic instability, renegotiations are more frequent. This is particularly relevant in countries where the distribution of risks between the parties is furthest from theoretical precepts. The case of Argentina is an unequivocal example of this experience. The transfer of most road corridors to the private sector in the early 1990s in Argentina was carried out without any type of state guarantee. The risks were entirely transferred to the concessionaires. After a critical period of hyperinflation, social disapproval was so great that for some time toll collection had to be suspended. Subsequently, all PPP contracts were renegotiated. Brazil is another clear example where the transfer and sharing of risks in the first stage of awards was practically non-existent. Thanks to the country's greater political stability, however, this did not lead to widespread renegotiations.

A third conclusion is that countries with greater macroeconomic stability need fewer risk mitigation mechanisms. This is the case of France. In these cases, the uncertainty in the future of the work is significantly mitigated by the institutional environment, which allows for less use of state guarantees and a greater transfer of risks to the private sector. In the case of France, although the most important risks of the business are assumed by the private sector, the framework of institutional and macroeconomic stability helps to reduce the risk premium and uncertainty, which allows for less risk coverage by the state.

However, we also conclude that if risk distribution is inappropriate in countries where there is institutional and macroeconomic stability, real traffic demand becomes the key variable to determine the success or failure of the collaboration. This is the case of Chile. The economic slowdown that Chile experienced in the late 1990s led to a significant reduction in traffic. This event led to a general renegotiation of all public-private partnership agreements. All fixed-term contracts became variable-term contracts. Since the end of 2000, the model of concessions awarded using the Minimum Present Value of Income system has become the general model.

Finally, at a general level, all the experiences show a certain improvement in the degree of specification and concreteness of the distribution of risks over time. However, the risk of demand remains the most problematic to control given the difficulty of the institutional and macroeconomic environment to mitigate such a risk. For this reason, it is considered appropriate to recommend sharing demand risk among the parties involved as a public policy instrument. Currently, there are several mechanisms to facilitate sharing demand risk; such

as rate-of-return (RoR) regulation, regulation-betting with maximum price correction, minimum revenue/volume guarantee (MRG), dual band mechanisms (Cap and Floor) and least present value of revenues (LPVR). Implementing any of these mechanisms would significantly reduce the transaction costs associated with renegotiations when traffic suffers prolonged drops.

The second part of chapter 2 examines the evolution of the public-private partnership model in Spain from the late 1960s to the present day. A detailed analysis of the model shows that despite the legislative introduction of a two-tier risk mitigation mechanism, the model has continued to be based on a private approach that limits the impact of a concessional bankruptcy through the activation of the Administration's Asset Responsibility (RPA, in its Spanish acronym). This would explain the country's current oversupply of high-capacity road infrastructure.

At the end of the 1960s, the Administration's Asset Responsibility made sense because the legislative framework was very poorly developed, public resources were scarce and the need for mobility through high-capacity routes was becoming increasingly evident. In this first phase, the Administration's Asset Responsibility played a determining role as an effective stimulus to private participation. However, for the concessions awarded in the latest phase, the state guarantee of the Administration's Asset Responsibility has promoted incentives to develop PPPs for road infrastructure far beyond the rational needs.

In addition to the explicit guarantee of the Administration's Asset Responsibility, the latest period of concession awards is also notable for the accumulation of a series of public actions that has led to the collapse of the sector. First of all, there are significant deviations both in the costs of expropriation and construction and in traffic estimates. Secondly, it is important to highlight public investments that affected the new concessions' capacity to capture traffic, and the cancellation of public investments in complementary works that had previously been promised. Finally, one also observes how the expectations of expected profitability that were generated for concessions awarded near areas with significant urban development projection vanished with the bursting of the real estate bubble.

The result of this accumulation of public and private actions in the face of an oversupply of infrastructures arising from the abuse of the Administration's Asset Responsibility has led to the collapse of the sector after the start of the

latest financial crisis. In order to re-establish the economic and financial balance of the concessions, some contracts had to be renegotiated and other concessions were declared in suspension of payments due to bankruptcy. However, in order to avoid the premature liquidation of the concession and the activation of the Administration's Asset Responsibility, the state had to help the concessionaires to cover the debt and lately had to nationalize motorways.

As the Spanish experience shows, this concessional bankruptcy is not a unique event, given that after the oil crisis in the seventies and early eighties many concessionaires had to be rescued by the state through the creation of the public company ENA. The underlying problem is that despite the legislative modifications and the evidence of the difficulties in predicting traffic, a new concessional bankruptcy could not be avoided. In the latest stage, the abuse of the Administration's Asset Responsibility has generated an oversupply of high-capacity roads than what would be socially desirable and has transferred a large part of the risks to taxpayers. Thus, we conclude that the elimination of the Administration's Asset Responsibility from the Spanish legislation would ensure that a potential new public-private partnership would respond to real mobility needs and not to a business opportunity.

Chapter 3 quantifies and evaluates the welfare impact of one of the last tolled motorway political renegotiations which took place in Spain 1997. Despite many renegotiations of its tolled motorways lacking transparency, which affected the rates, the concession term, and the economic-financial benefits of the concession, no study to date has evaluated their real impact. This is the first study that evaluates their social and distributive impact on the welfare of the actors involved in political renegotiations.

In the late 1990´s a wave of political renegotiations were conducted by the government in order to comply with the Maastricht Treaty. These renegotiations involved the modification of several tolled motorways concessions, with contractual extensions in return for lower tolls that could both transfer and reduce logistical costs. This is the case of the Tarragona-Valencia and Valencia-Alicante sections of the AP-7 motorway. At the end of 1997, the contract of both sections were renegotiated with the object of stimulating a greater use of the road sections, because of the located itineraries where placed in roads with high economic activity that absorb an important traffic volume. The main renegotiation bases consist in a reduction of the toll fares around 33% for the road users and an investment of 24 million euros in road safety

improvements for the concessionaire. As a counterpart of toll reduction and road investment, the concessionaire contract was extended to 13 years. After the renegotiation, the contract instead of ending in 2006 would end in 2019.

The first conclusion of this analysis is that road users were aside of the renegotiation, what facilitated an outcome damaging their welfare. The puplic, as well as toll motorway users, are largely unaware of the long-term effects of renegotiations. Private concessionaires and the government negotiated bilaterally. Indeed, the study reveals that the main losers of the renegotiation were precisely the road users, even though tolls were reduced in the short term. The renegotiation damaged road user's welfare by improving government's and firm's welfare. Obviously, the main winner of the renegotiation in absolute terms was the concessionaire. However if we analyze the welfare impact of the renegotiation in relative terms, the leader was always the government. This is because under private management governments avoid any maintenance and operating costs and can collect taxes from the firm (corporation tax) and road users (value added tax).

However, the welfare analysis shows that the most equitable solution for road users would have been the absence of no renegotiation. Nevertheless, a second best alternative for road users could have been no renegotiation with government cost-based tolls. It means that even if the government opts to charge cost based tolls, road users are always better off than in the real scenario of renegotiation.

Finally, the analysis also reveals that renegotiation would have left users indifferent, while still granting welfare gains for government and for the concessionaire negotiating a greater reduction in tolls. Certainly, a toll reduction between 44.1% and 46.3% instead of the real 33% would have improved the road user's welfare without severely harming the other actor's welfare.

This kind of renegotiations based on political incentives transfer welfare from road users to taxpayers. In order to avoid high welfare losses for a particular group of actors, shadow tolls would be an alternative to direct payments.

Chapter 4 examines the effects of PPPs on road safety outcomes by taking the advantages of the variety of management models provided by the Spanish highways network. A detailed econometric analysis on count data for the period 2008-2012 shows that the most relevant aspects influencing road safety outcomes is the quality of design of the road. Highways built with high-quality

standards are safer than highways constructed with low-quality standards. The annual number of accidents with victims and the annual number of victims on highways is lower under highways with high-quality design.

Moreover, we find evidence suggesting that public-private partnership perform better in terms of road safety outcomes than public management models under traditional procurement, for roads with a similar quality of design. The annual number of accidents with victims and the annual number of victims on high-quality design highways is lower under public-private partnerships. Private management has a significant and positive effect on road safety. This is especially relevant in the case of roads that have been built with high geometric characteristics. This result also keeps for the annual number of victims on highways with low-quality design. Albeit it is necessary more investigation to understand the reason behind these results, in order to promote safety roads across the country, some general recommendations should be considered.

Firstly, for road safety purposes, highways should be constructed with high-quality standards because once the road is constructed modifying the geometrical characteristics is expensive and costly. If there is no other alternative because the road has already been constructed with low-quality standards, investment in safety elements such as traffic signs, lighting and security barriers might significantly contribute to reduce casualties. Low-quality roads that were transferred to the private sector through PPP contracts suffer less victims than those that remained public, and this was probably due to the rehabilitation and investments involved in the contract. Although this recommendation of building roads following the best standards of quality could seem obvious, this should always be contrasted to a Cost Benefit Analysis, considering the largest welfare gains associated with several externalities such as road safety, and the largest investment (opportunity cost) required.

Second, regulatory requirements for geometrical design, construction standards and management features should not be distinctive between public and private procurement. Privatization processes, especially those involving a contractual relationship between the government and the private sector usually involves the substitution of ownership by regulation. As stated in Albalate et al., (2009), governments tend to sophisticate and be more concrete and stringent with road managers after the privatization of infrastructure. The loss of control provided by ownership is substituted by regaining control through regulation.

Thus, regulatory differences might explain part of the reason why private operator seems to achieve better safety outcomes.

Third, incentives to monitor the quality indicators should be applied indifferently onto roads managed by public operator and onto roads managed by private companies. PPPs contracts establish a set of performance-based indicators that oblige the private operator to guarantee the road surface pavement and safety elements in the most optimal conditions for drivers. Also, recent private concessions introduced into the contract an incentive mechanism based on bonus and penalties related to the performance. Conversely, public operator does not have incentives to offer better performance because the state is not subjected to direct regulation. Finding ways to introduce incentives to public managers in order to favor their safety outcomes could also be an interesting public policy reform.

Bibliography

Abdel Aziz, A.M., 2007a. A survey of the payment mechanisms for transportation DBFO projects in British Columbia. Construction Management and Economics, 25(5), 529-543.

Abdel Aziz, A.M., 2007b. Successful Delivery of Public-Private Partnerships for Infrastructure Development. Journal of Construction Engineering and Management, 133(12), 918-931.

Abdel-Aty, M.A., Radwan, A.E., 2000. Modelling Traffic Accident Occurrence and Involvement. Accident Analysis and Prevention 32(5), 633-642.

ADB, 2008. Public-private Partnerships Handbook. Manila: Asian Development Bank.

Albalate, D., 2008. Lowering blood alcohol content levels to save lives: the European experience. Journal of Policy Analysis and Management 27(1), 20-39.

Albalate, D., 2011. Shifting death to their alternatives: The case of toll motorways. Journal of Transport Economics and Policy 45(3), 453-479.

Albalate, D., 2014. The Privatisation and Nationalisation of European Roads: Success and failure in Public Private Partnerships. Cheltenham: Edward Elgar.

Albalate, D., Bel, G., 2009. Regulating concessions of toll motorways: An empirical study on fixed vs. variable term contracts. Transportation Research Part A, 43(2), 219-229.

Albalate, D., Bel, G., 2012. Motorways, tolls and road safety: Evidence from Europe. Journal of Spanish Economic Association 3(4), 457-473.

Albalate, D., Bel, G., Bel-Piñana, P., 2015. Tropezando dos veces con la misma piedra: Quiebra de autopistas de peaje y costes para contribuyentes y usuario. Revista de Economía Aplicada, 23 (67), 131-152.

Albalate, D., Bel, G., Fageda, X., 2009. Privatization and regulatory reform of toll motorways in Europe. Governance 22(2), 295-318.

Albalate, D., Bel, G., Fageda, X., 2015. When supply travels far beyond demand: Causes of oversupply in Spain's transport infrastructure. Transport Policy, 41, 80-89.

Albalate, D., Bel, G., Geddes, R.R., 2017. How much vertical integration? Contractual Choice and Public-Private Partnerships in the United States. Review of Industrial Organization 51, 25-42.

Albalate, D., Fernández, L., Yarygina, A., 2013. The road against fatalities: Infrastructure spending vs. regulation??. Accident Analysis and Prevention 59, 227-239.

Allison, P.D., Waterman, R., 2002. Fixed effects negative binomial regression models. Sociological Methodology 32(1), 247-265.

Amorelli Amorelli, L., 2009. Brazilian Federal Road Concessions: New Challenges to the Regulatory Framework. Washington DC: The George Washington University-Minerva Program.

Anastasopoulos, P.C., Mannering, F.L., 2009. A note on modeling vehicle accident frequencies with random-parameters count models. Accident Analysis and Prevention 41(1), 153-159.

Athias, L., Nuñez, A., 2008. Winner's curse in toll road concessions. Economic letters 101(3), 172-174.

Baeza, M.A., Vassallo, J.M., 2008a. Renegociaciones de los contratos de concesión de autopistas de peaje en España y su influencia sobre los incentivos en la licitación. Universidad de Granada y Universidad Politécnica de Madrid.

Baeza, M.A., Vassallo, J.M., 2008b. Traffic uncertainty in toll motorway concessions in Spain: an analysis of the ramp-up period. TRANSyT 2008-01, Universidad Politécnica de Madrid; Workin Paper.

Baeza, M.A., Vassallo, J.M., 2012. Traffic uncertainty in toll motorway concessions in Spain. Proceedings of the Institution of Civil Engineers-Transport, 165(2), 97-105.

Bain, R., 2009. Error and optimism bias in toll road traffic forecasts. Transportation, 36(5), 469-482.

Bak, M., Burnewicz, J., 2005. Financing Motorways in Poland. Research in Transportation Economics, 15, 145-155.

Baumgarten, P., Middelkamp, J., 2015. On interurban road pricing schemes and the impacts of traffic diversion on road safety in Germany: Empirical findings and implications. European Journal of Transport and Infrastructure Research 15(2), 147-162.

Bel, G., 1999. Financiación de infraestructuras viarias: La economía política de los peajes. Papeles De Economía Española, 82, 123-139.

Bel, G., Fageda, X., 2005. Is a mixed funding model for the highway network sustainable over time? The Spanish case. Research in Transportation Economics, 15, 187-203.

Bel, G., Foote, J., 2009. Tolls, Terms, and Public Interest in Road Concessions Privatization: A Comparative Analysis of Recent Transaction in the USA and France. Transport Reviews 29(3), 397-413.

Bellod, J.L., 2006. Financiación privada de infraestructuras: El caso de la Autovía del Noroeste. Presupuesto y Gasto Público 44(2006), 133-144.

Benito, B., Montesinos, V., 2003. Análisis de la Financiación ¿Privada? de Infraestructuras. Revista Valenciana de Economía y Hacienda 9(2003), 9-28.

Bennett, J., Iossa, E., 2006. Building and Managing Facilities for Public Services. Journal of Public Economics 90(10-11), 2143-2160.

Bitsch, F., Buchner, A., Kaserer, C., 2010. Risk, Return and Cash Flow Characteristics of Infrastructure Fund Investments. EIB Papers, 15(1), 106-136.

Blanc-Brude, F., Goldsmith, H., Välilä, T., 2009. A Comparison of Construction Contract Prices for Traditionally Procured Roads and Public–Private Partnerships. Review of Industrial Organization 35(1-2), 19-40.

Block, W., 2009. The Privatization of Roads and Highways: Human and Economic Factors. Ludwig von Mises Institute

Broughton, J., Gower, P., 1998. The likely effects of motorways tolling on accident risk-phase 2. TRL Report TRL 352, Transport Research Laboratory, Crowthorne.

Burningham, S., Stankevich, N., 2005. Why road maintenance is important and how to get it done. The World Bank, Washington, DC. Transport Note (TRN-4).

Caliendo, C., Guida, M., Parisi, A., 2007. A crash-prediction model for multilane roads. Accident. Analysis and Prevention 39(4), 657-670.

Cameron, A.C., Trivedi, P.K., 2005. Microeconometrics. Methods and Application. Cambridge: Cambridge University Press.

Carpintero, S., 2002. Las concesiones de carreteras en los países en vías de desarrollo. El caso de Argentina y de México. Revista de obras públicas, 3425, 113-118.

Castillo-Manzano, J.I., Castro-Nuño, M., Fageda, X., 2016. Exploring the relationship between truck load capacity and traffic accidents in the European Union. Transportation Research Part E 88, 94-109.

Chasey, A.D., Maddex, W.E., Bansal, A., 2012. Comparison of public-private partnerships and traditional procurement methods in North American highway construction. Transportation Research Record: Journal of the Transportation Research Board 2268(1), 26-32.

Chin H.C., Quddus, M.A., 2003. Applying the random effect negative binomial model to examine traffic accident occurrence at signalized intersections. Accident Analysis and Prevention 35(2), 253-259.

De Palma, A., Prunier, G., Leruth, L., 2009. Towards a principal-agent based typology of risks in public-private partnerships. International Monetary Fund, 9(177).

Dee, T.S., Grabowski, D.C., Morrisey, M.A., 2005. Graduated driver licensing and teen traffic fatalities. Journal of Health Economics 24(3), 571-589.

Delmon, J., 2009. Private Sector Investment in Infrastructure: Project Finance, PPP Projects and Risks. Kluwer Law International: Second Edition.

Eisenberg, D., 2004. The mixed effects of precipitation on traffic crashes. Accident analysis and prevention 36(4), 637-647.

Engel, E., Fischer, R., Galetovic, A., 1996. Licitación de carreteras en Chile. Estudios Públicos, 61, 5-37.

Engel, E., Fischer, R., Galetovic, A., 1997. Highway franchising: pitfalls and opportunities. The American Economic Review, 87(2), 68-72.

Engel, E., Fischer, R., Galetovic, A., 2001, Least-present-value-of-revenue auctions and highway franchising. Journal of Political Economy, 109(5), 993-1020.

Engel, E., Fischer, R., Galetovic, A., 2003a. Soft Budgets and Highway Franchising. 4th Annual Latin America Conference of Infrastructure and Resources, Stanford Centre for International Development and Stanford Institute for Economic Policy Research.

Engel, E., Fischer, R., Galetovic, A., 2003b. Privatizing highways in Latin America: is it possible to fix what went wrong? Economía, Journal of the Latin American and Caribbean Economics Association 4(1), 129-164.

Engel, E. Fischer, R., Galetovic, A., 2006a. Privatizing highways in the United States. Review of Industrial Organization, 29(1-2), 27-53.

Engel, E., Fischer, R., Galetovic, A., 2006b. Renegotiation without holdup: Anticipating spending and infrastructure concessions. National Bureau of Economic Research.

Engel, E., Fischer, R., Galetovic, A., 2014. The economics of public-private partnerships. A basic guide. Cambridge: Cambridge University Press.

Engel, E., Fischer, R., Galetovic, A., Hermosilla, M., 2009a. Renegociación de concesiones en Chile. Estudios Públicos, 113, 151-205.

Engel, E., Fischer, R., Galetovic, A., 2009b. Public-private partnerships: when and how. Stanford Center for International Development; Working Paper.

Estache, A., Carbajo, J., 1996. Designing Toll Road Concessions- Lessons from Argentina. Public Policy for the Private Sector Viewpoints. Washington DC: The World Bank Group.

European Commission, 2003. Guidelines for Successful Public-Private Partnership. European Commission.

European Commission, 2010. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Towards a European road safety area: policy orientations on road safety 2011-2020. European Commission.

Eurostat, 2016. Manual on Government Deficits and Debt Implementation of ESA 2010. Eurostat.

Fayard, A., Meunier, D., Quinet, E., 2012. Motorway provision and management in France: Analyses and policy issues. Networks and Spatial Economics, 12(2), 299-319.

Galiani, S., Gertler, P., Schargrodsky, E., 2005. Water for life: The impact of the privatization of water supply on child mortality. Journal of political economy, 113(1), 83-120.

Gandil, P., 2005. Development of the motorway infrastructure in France: Background and recent developments. P3 2006: The 13th Annual Conference on Public-Private Partnerships, Toronto.

GAO, 1999. Public-Private Partnerships. Terms Related to Building and Facility Partnerships. United States General Accounting Office.

Geddes, R.R., 2014. Competition issues and private infrastructure investment through public-private partner- ships. In: Cheng, T. K., Lianos, I., Sokol, D., (Eds), Competition and the State. Palo Alto, CA: Stanford University Press.

Geddes, R.R., Wagner, B.L., 2013. Why do U.S. states adopt public-private partnership enabling legislation?. Journal of Urban Economics, 78, 30-41.

Gomes, S.V., Cardoso, J.L., 2012. Safety effects of low-cost engineering measures. An observational study in a Portuguese multilane road. Accident Analysis and Prevention 48, 346-352.

Gómez-Ibáñez, J.A., Meyer, J.R., 1993. Going private: The international experience with transport privatization. Washington, DC: The Brookings Institution.

Graeff, F., 2011. Uma análise da alocação de riscos nos contratos para prestação de serviços públicos: o caso do transporte rodoviário interestadual de passageiros por ônibus. Brazilia: Tribunal de Contas da União.

Greene, W., 2007. Functional form and heterogeneity in models for count data. Foundations and Trends in Econometrics 1(2), 113-218.

Grimsey, D., Lewis, M.K., 2002. Evaluating the risks of public private partnerships for infrastructure projects. International Journal of Project Management 20(2), 107-118.

Grimsey, D., Lewis, M.K., 2004. Public private partnerships: The worldwide revolution in infrastructure provision and project finance. Cheltenham: Edward Elgar.

Grimsey, D., Lewis, M.K., 2007. Public private partnerships: The worldwide revolution in infrastructure provision and project finance. Cheltenham: Edward Elgar.

Guasch, J., 2004. Garanting and Renegotiating Infrastructure Concessions. Doing it Right. The World Banck, Washington.

Guasch, J., Laffont, J., Straub, S., 2008. Renegotiation of concession contracts in Latin America. Evidence from the water and transport sector. International Journal of Industrial Organitzation 26(2), 421-442.

Hadi, M., Aruldhas, J., Chow, L.F., Wattleworth, J., 1995. Estimating safety effects of cross-section design for various highway types using negative binomial regression. Transportation Research Record 1500, 169-177.

Hammami, M., Ruhashyankiko, J.F., Yehoue, E.B., 2006. Determinants of public-private partnerships in infrastructure. International Monetary Fund, working paper.

Harris, S., 2004. Public private partnerships: delivering better infrastructure services. Inter-American Development Bank, working paper.

Hart, O., 2003. Incomplete contracts and public ownership: Remarks, and an application to public private partnerships. The Economic Journal, 113(486), 69-76.

Hart, O., A. Shleifer., Vishny, R.W., 1997. The Proper Scope of Government: Theory and an Application to prisons. The Quarterly Journal of Economics 112(4), 1127-1162.

Hartz, A.J., Krakauer, H., Kuhn, E.M., Young, M., Jacobsen, S.J., Gay, G., Rim, A.A., 1989. Hospital characteristics and mortality rates. New England Journal of Medicine, 321(25), 1720-1725.

Hausman, J.A., Hall, B.H., Griliches, Z., 1984. Econometric Models for Count Data with an Application to the patents-R&D Relationship. Econometrica 52(4), 909-938.

Hermans, E., Brijs, T., Stiers, T., Offermans, C., 2006. The impact of weather conditions on road safety investigated on an hourly basis. In: Proceedings of the 85thAnnual meeting of the Transportation Research Board. Washington, D.C, 1-16.

HM Treasury, 2003. PFI: meeting the investment challenge. HM Treasury.

Hodge, G.A., Greve, C., 2007. Public–Private Partnerships: An International Performance Review. Public Administration Review 67(3), 545-558.

Hodge, G.A., Greve, C., Boardman, A.E., 2010. Introduction: the PPP phenomenon and its evaluation. In: Hodge, G.A; Greve, C; Boardman, A.E. (Eds.), International Handbook of Public-Private Partnerships. Cheltenham: Edward Elgar, 3-16.

Holguín-Veras, J., Cetin, M., Xie, S., 2006. A comparative analysis of US toll policy. Transportation Research Part A 40(10), 852–871.

Hosseinpour, M., Yahaya, A.S., Sadullah, A.F., 2014. Exploring the effects of roadway characteristics on the frequency and severity of head-on crashes: Case studies from Malaysian Federal Roads. Accident Analysis and Prevention 62, 209-222.

Imprialou, M.I.M., Quddus, M., Pitfield, D.E., Lord, D., 2016. Re-visiting crash–speed relationships: A new perspective in crash modelling. Accident Analysis and Prevention 86, 173-185.

International Road Assessment Program, 2015. Vaccines for roads. International Road Assessment Program.

Iossa, E., Martimort, D., 2015. The simple microeconomics of public-private partnerships. Journal of Public Economic Theory, 17(1), 4-48.

Iossa, E., Spagnolo, G., Vellez, M., 2007. Best practices on contract design in public-private partnerships. World Bank; Working Paper.

Izquierdo, R., 1997. Gestión y financiación de las infraestructuras de transporte terrestre. Madrid, Asociación Española de la Carretera.

Jovanis, P.P., Chang, H-L., 1986. Modeling the relationship of accidents to miles traveled. Transportation Research Record 1068, 42-51.

Keeler, E.B., Rubinstein, L.V., Kahn, K.L., Draper, D., Harrison, E.R., McGinty, M.J., Rogers, W.H., Brook, R.H., 1992. Hospital characteristics and quality of care. Journal of the American Medical Association, 268(13), 1709-1714.

Kerf, M., Garay, R., Irwin, T., Levesque, C., Taylor, R., 1998. Concessions for infrastructure. A guide to their design and award. World Bank Technical paper 399.

Kusnet, D., 2007. Highway Robbery II. The Many Problems with Outsourcing Design, Engineering, Inspection & Supervision of Federally-Funded Transportation Projects: Increased Costs, reduced Quality & Safety, and Little Accountability to the Public. National Association of State Highway and Transportation Unions, 1-38.

Lilley, M., DeGiorgio, C., 2004. A private-sector perspective. Australian Accounting Review, 14(33), 34-41.

Loeb, P.D., 2001. The effectiveness of seat belt legislation in reducing driver involved injury rates in Maryland. Transportation Research Part E 37(4), 297-310.

Lord, D., 2006. Modelling motor vehicle crashes using Poisson-gamma models: Examining the effects of low sample mean values and small sample size on the estimation of the fixed dispersion parameter. Accident Analysis and Prevention 38(4), 751-766.

Lord, D., Manar, A., Vizioli, A., 2005a. Modeling crash-flow-density and crash-flow-V/C ratio relationships for rural and urban freeway segments. Accident Analysis and Prevention 37(1), 185-199.

Lord, D., Washington, P., Ivan, J.N., 2005b. Poisson, Poisson-gamma and zero-inflated regression models of motor vehicle crashes: balancing statistical fit and theory. Accident Analysis and Prevention 37(1), 35-46.

Lord, D., Mannering, F., 2010. The statistical analysis of crash-frequency data: a review and assessment of methodological alternatives. Transportation Research Part A 44(5), 291-305.

Lucas, D., 2010. Measuring and Managing Federal Financial Risk. Chicago: University of Chicago Press.

Lucas, D., 2012. Valuation of government policies and projects. Annual Review of Financial Economics, 4(1), 39-58.

Lyles, R.W., Stamatiadis, P., Blower, D., Campbell K., 1990. The Michigan heavy truck study – Final Report. College of Engineering, Michigan State University.

Mannering, F.L., Bhat, C.R., 2014. Analytic methods in accident research: Methodological frontier and future directions. Analytic Methods in Accident Research 1, 1-22.

Marin, P., 2009. Public private partnerships for urban water utilities: A review of experiences in developing countries. World Bank Publications, 8.

Martimort, D., Pouyet, J., 2008. To build or not to build: Normative and positive theories of public-private partnerships. International Journal of Industrial Organization 26(2), 393-411.

Martin, J., 2002. Relationship between crash rate and hourly traffic flow on interurban motorways. Accident Analysis and Prevention 34 (5), 619–629.

Matas, A., Raymond, J., 2003. Demand elasticity on tolled motorways. Journal of Transportation and Statistics, 6(2), 91-108

Meuleners, H.M., Hendrie, D., Lee, A.H., Legge, M.G., 2008. Effectiveness of the Black Spot Programs in Western Australia. Accident Analysis and Prevention 40(3), 1211-1216.

Miaou, S.P., Lum, H., 1993. Modeling vehicle accidents and highway geometric design relationships. Accident Analysis and Prevention 25(6), 689-709.

MOPU, 1984. Plan General de Carreteras 1984-91. Dirección General de Carreteras del Ministerio de Obras Públicas y Urbanismo.

Nassima, R., 2012. Water partial privatization: access and quality consequences for urban areas in Senegal. Economies and finances (dumas-00811476).

National Audit Office (NAO), 2003. PFI: Construction Performance, HC 371. London, UK: National Audit Office.

National Audit Office (NAO), 2009. Performance of PFI construction. A review by the private finance practice. London, UK: National Audit Office.

Nilsson, G., 2004. Traffic Safety Dimensions and the Power Model to Describe the Effect of Speed on Safety. Bulletin, 221. Lund Institute of Technology, Lund.

Noland, R.B., 2003. Traffic fatalities and injuries: the effect of changes in infrastructure and other trends. Accident Analysis and Prevention 35(4), 599-611.

Noland, R.B., Oh, L., 2004. The effect of infrastructure and demographic change on traffic-related fatalities and crashes: a case study of Illinois county-level data. Accident Analysis and Prevention 36(4), 525-532.

Nombela, G., De Rus, G., 2001. Auctions for infrastructure concessions with demand uncertainty and unknown costs. University of Las Palmas: Munich Personal RePEc Archive Paper.

Nombela, G., De Rus, G., 2004. Flexible-term contracts for road franchising. Transportation Research A, 38(3), 163-247.

O'Donnell, P., 2009. Establishing Measurable and Reportable KPIs. Chatswood NSW: Leighton Contractors.

OECD, 2008. Public-Private Partnerships: In Pursuit of Risk Sharing and Value for Money. Organization for Economic Cooperation and Development.

Osborne, S., 2002. Public-private partnerships: Theory and practice in international perspective. Routledge.

Pei, X., Wong, S.C., Sze, N.N., 2012. The roles of exposure and speed in road safety analysis. Accident Analysis and Prevention 48, 464-471.

PEIT, 2005. Plan Estratégico de Infraestructuras y Transporte. Ministerio de Fomento.

Pérez, I., 2006. Safety impact of engineering treatments on undivided rural roads. Accident Analysis and Prevention 38(1), 192-200.

Perkins, S., 2013. Better Regulation of Public-Private Partnerships for Transport Infrastructure: Summary and Conclusions. Discussion paper International Transport Forum. Paris, France: OECD.

Phillips, R., 2008. Matrix of Risks Distribution-Roads. PPP in Infrastructure Resource Center for Contracts, Laws and Regulations. The World Bank; Washington, US.

Prior, J., Puelles, J.J., 2012. La financiación de las concesionarias de autopistas. In: Morera, J.M., Prior, J. (Eds.), Las Autopistas de Peaje en España. Madrid: ASETA, 54-63.

Puncel, A., 1996. La Autopista del Mediterráneo: Cesiones, concesiones, servicios y servidumbres. Valencia: Servei de Publicacions de la Universitat de València.

Quddus, M., 2013. Exploring the relationship between average speed, speed variation, and accident rates using spatial statistical models and GIS. Journal of Transportation .Safety and Security 5(1), 27-45.

Rachwalski, M.D., Ross, T.W., 2010. Running a government's P3 program: Special purpose agency or line departments?. Journal of Comparative Policy Analysis, 12(3), 275-298.

Raisbeck, P., Duffield, C., Xu, M., 2010. Comparative performance of PPPs and traditional procurement in Australia. Construction Management and Economics, 28(4), 345-359.

Rangel, T., Vassallo, J.M., 2015. Modeling the effect of contractual incentives on road safety performance. Transport Policy 40, 17-23.

Rangel, T., Vassallo, J.M., Arenas, B., 2012. Effectiveness of safety-based incentives in Public Private Partnerships: Evidence from the case of Spain. Transportation Research Part A 46(8), 1166-1176.

Rangel, T., Vassallo, J.M., Herraiz, I., 2013. The influence of economic incentives linked to road safety indicators on accidents: The case of toll concessions in Spain. Accident Analysis and Prevention 59, 529-536.

Ridao, J., García, A., 2013. La precaria viabilidad de determinadas concesiones de autopistas de peaje en España. Lecciones estructurales para el modelo de colaboración público-privada y una propuesta de solución coyuntural. Revista Andaluza de Administración Pública, 87, 95-135.

Robinson, J.A., Torvik, R., 2005. White elephants. Journal of Public Economics, 89(2-3), 197-210.

Russo, F., Zampino, R., 2010. Machiavellian PPP? Evidence from Italian local government's projects for public services. In: International Public Procurement Conference, Seoul, South Korea, 26-28.

Samuel, P., Poole, R., 2000. Putting Customers in the Driver's Seat: The Case for Tolls. Policy Study, 274. Reason Public Policy Institute.

Sánchez, A., Vassallo, J.M., Castroman, A., Delgado, C., 2007. Nuevo modelo de gestión concesional en autovías de primera generación. Estudios de Construcción y Transporte 106, 157-178.

SEOPAN, 2014. Infraestructuras, consideraciones, desafíos y previsiones. Available in www.seopan.es

Serafinoff, V., 2008. Transformaciones en el rol del Estado. La concesión de redes viales en Argentina. Estado, Gobierno, Gestión Pública. Revista Chilena de Administración Pública, 11, 5-38.

Shortell, S., Hughes, E.F., 1988. The effects of regulation, competition, and ownership on mortality rates among hospital inpatients", New England Journal of Medicine, 318(17), 1100-1107.

Sisiopiku, V.P., Waid, J.C., Rizk, T., McLeod, R., Robbins, W., 2006. Alternate Financing Sources for Alabama Highways. University Transportation Center for Alabama.

Souto, G., 2001. Trabajo y capital en la evaluación pública de proyectos. Madrid, Instituto de Estudios Fiscales, Serie Investigaciones 6.

Swan, P.F., Belzer, M.H., 2013. Tolling and economic efficiency: do the pecuniary benefits exceed the safety costs?. Public Works Management and Policy 18(2), 167-184.

Tello, C., 2008. Modelos aplicados de colaboración público-privada por la Administración Pública: Experiencias en la Administración General del Estado. Revista Española de Control Externo, 10(28), 65-88.

Tirole, J., 1999. Incomplete contracts: Where do we stand?. Econometrica, 67(4), 741-781.

Van Ham, H., Koppenjan, J., 2001. Building public–private partnerships: Assessing and managing risks in port development. Public Management Review 4(1), 593–616.

Vassallo, J.M., Ortega, A., Baeza, M.A., 2012. Impact of the economic recession on toll highway concessions in Spain. Journal of Management in Engineering, 28(4), 398-406.

Vining, A.R., Boardman, A.E., Poschmann, F., 2005. Public-private partnerships in the US and Canada: There are no free lunches. Journal of Comparative Policy Analysis, 7(3), 199-220.

Wang, C., Quddus, M.A., Ison, S.G., 2013. The effect of traffic and road characteristics on road safety: A review and future research direction. Safety science 57, 264-275.

Williamson, O., 1976. Franchise bidding for natural monopolies-in general and with respect to CATV. The Bell Journal of Economics, 7(1), 73-104.

Williamson, O., 1985. The Economic Institutions of Capitalism: firms, markets, relational contracting. The Free Press: New York.

World Bank, 2011.Public-Private Partnerships in Europe and Central Asia. The World Bank.

World Bank, 2012. Public-Private Partnerships reference guide. The World Bank.

World Health Organization, 2015. Global status report on road safety 2015. World Health Organization.

Yaacob, W.F.W., Lazim, M.A., Wah, Y.B., 2011. Applying Fixed Effects Panel Count Model to Examine Road Accident Occurrence. Journal of Applied Sciences 11(7), 1185-1191.

Yescombe, E., 2007. Public-private partnerships. Principles of policy and finance. Burlington, MA, USA: Butterworth-Heinemann, Elsevier Finance.