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Why traffic forecasts in PPP contracts are often overestimated?

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CONTENTS

ABSTRACT	2
INTRODUCTION	3
THE TRAFFIC RISK PROBLEM	4
DEFINITION OF TRAFFIC RISK	4
TRAFFIC ACCURACY IN TRANSPORT PROJECTS: CONCESSIONS VS. PUBLIC PROCUREMENT	6
MECHANISMS TO MITIGATE TRAFFIC RISK	9
TRIGGER VARIABLES	9
WHO SETS THE TRIGGER LEVEL?	11
SHARING THE RISK	11
COMPENSATION MECHANISM	12
DESIGN AND ASSESSMENT OF MITIGATION STRATEGIES	13
PROCUREMENT, RENEGOTIATION AND TRAFFIC INNACURACY	17
PROCUREMENT	18
INCOMPLETE CONTRACTS AND RENEGOTIATION	23
DOES PROCUREMENT AND RENEGOTIATION HAVE TO DO WITH THE INACCURACY OF TRAFFIC ESTIMATIONS?	25
CASE STUDY: CONCESSION CONTRACTS IN SPAIN	27
BRIEF HISTORY	27
RENEGOTIATION OF CONCESSION CONTRACTS IN SPAIN	30
RESEARCH METHODOLOGY AND EMPIRICAL ANALYSIS	31
<i>Objectives and Methodology</i>	31
<i>Data</i>	34
<i>Results</i>	35
CONCLUSSIONS AND FURTHER RESEARCH	37
REFERENCES	40

WHY TRAFFIC FORECASTS IN PPP CONTRACTS ARE OFTEN OVERESTIMATED?

ABSTRACT

In this paper we discuss the possible reasons why traffic is often overestimated by bidders in PPP contracts. We propose that forecasting errors can be divided into natural errors, which are a consequence of model inaccuracy, and strategic errors, which are intentionally caused by bidders in the tender in order to be granted the concession. Accordingly, we postulate that strategic errors depend on four aspects which are: the competitiveness of the tender, the incompleteness of the contract, the willingness of the government to renegotiate, and the lack of mechanisms to mitigate traffic risk. We contrast this approach with the case study of concession contracts in Spain, where the willingness to renegotiate shown by the government has been notorious. We found that, on average, there is a clear bias towards overestimation though the behaviour of any single concession may not have much to do with the average. In addition, we found that unlike what happens with annual traffic volumes, traffic growth rates are mostly underestimated by concessionaires in the ramp-up period. We explain this trend towards overestimation in the strategic behaviour of the bidders in the tender rather than in systematic modelling errors.

INTRODUCTION

Many governments are implementing new ways to encourage private participation in constructing, financing, and operating transport infrastructure. One of the most common ways to boost private participation is through Public Private Partnerships (PPPs). According to the White Paper on Public Private Partnerships by the European Commission (2004), PPPs are classified in contractual PPPs and institutionalised PPPs. The most common type of contractual PPP is the concession contract whereby the government or a public authority transfers construction, maintenance, and operation of the infrastructure to a private consortium, in exchange for which that consortium receives the right to charge a user fee, for a period of time, fixed or variable, as contractually agreed upon in advance (Vassallo, 2004).

PPP contracts have a long tradition in some countries, such as the United Kingdom (Debande, 2002), Spain (Izquierdo and Vassallo, 2004), France (Fayard and Bousquet, 1998), Chile (Gómez-Lobo, 2000) and Mexico (Guasch, Laffont and Straub, 2003). Presently, the United States is testing the concession contract model to manage transport infrastructure and monetize valuable transport assets (Foote, 2006). According to the Public Works Financing magazine (2006), the number of transport PPP projects contracted in 2003 in the world totalled 1,479, which means an accumulated investment of US\$579.5 billion.

Contractual PPPs are long-term contracts that are tendered on the basis of competition among several bidders. One of the main challenges of this kind of PPPs is to establish a correct risk-sharing framework between the private and the public sector. These contracts bear many risks, such as construction, expropriation, maintenance and operation, legal, political and so on (Flyvberg, Bruzelius and Rothengatter, 2003). Traffic has become one of the most important

risks as well as the most difficult to manage.

The aim of this paper is to analyze traffic inaccuracies in PPP projects, explain the reasons why there is this inaccuracy, and propose means to encourage bidders to be more realistic. We found that inaccuracies are relevant and have a clear bias towards overestimating. We postulate that the errors are not only a consequence of the modelling process but they are also a consequence of the intentional errors committed by the bidders out of strategic reasons.

In the first section of the paper, we analyse the traffic risk problem and we revise other empirical studies that evaluate the accuracy of traffic estimations. In the second section, we carry out a classification of the main mechanisms available nowadays to mitigate traffic risk. In the third section we evaluate how procurement and renegotiation influence traffic risk. In the fourth section we analyse the case of toll motorway concessions in Spain. In the last section we offer a set of conclusions and policy recommendations.

THE TRAFFIC RISK PROBLEM

Definition of Traffic Risk

Traffic risk can be defined as the inability for the concessionaire to determine with precision the traffic flow that will come up in the future. According to this definition, traffic risk could be evaluated ex-post by contrasting the estimated traffic and the actual traffic. However, in making this analysis, we should distinguish between the traffic errors that are committed unintentionally and the traffic errors that are committed intentionally by the forecaster for strategic reasons. This is the reason why we have to distinguish between two kinds of traffic projections: “true projections” and “manipulated projections”. True projections are the

projections that would be honestly conducted by the forecaster in order to be as accurate as possible. Manipulated projections are, however, the projections that have been intentionally modified by the forecaster for strategic reasons.

Following these approach we are able to make a distinction between two kinds of errors that we call “natural errors” and “strategic errors”. Natural errors can be defined as the difference between the true traffic projections and the ultimate real traffic. However, manipulated errors are the difference between the true traffic projections and the manipulated traffic projections. Natural errors show the inaccuracy of the predictions whereas manipulated errors show the bias intentionally introduced by the forecaster for strategic reasons. There are many examples of manipulated errors. For instance, a government that want to justify the construction of a white elephant project, or a bidder that inflates traffic forecast to bid aggressively.

Although the distinction between “natural” and “manipulated” errors is clear from a theoretical point of view, capturing this difference with empirical data is rather complicated. As we carry out an analysis from the empirical point of view, we are able only to contrast the estimated traffic that the forecaster (the government, a concessionaire, a financial institution, etc.) presented on a piece of paper with the actual traffic that ultimately happens to be. The result of this contrast gives us the addition of the “natural error” and the “manipulated error”. Unfortunately, capturing each one of the errors is rather complicated.

De Jong et al. (2007) have conducted an interesting research aimed at determining the reasons that explain “natural errors” in forecasting traffic. They claim that these errors are caused by input uncertainty and model uncertainty. Input uncertainty refers to the difficulty of accurately knowing the value of the inputs that determine traffic forecasts. Model uncertainty refers, however, to errors inherent to the characteristic of the model used, such as specification errors

in the model equations and errors due to using parameter estimates instead of the true value. From an analysis conducted in a case study in the Netherlands, they concluded that the contribution of input uncertainty to the bulk of the “natural error” is generally much larger than that of model uncertainty.

Some characteristics of PPP projects that can contribute at increasing the uncertainty in the inputs are: greenfield vs. existent project, the transport alternatives to the PPP project, the economic stability in the region, and the urban development expectations. A greenfield project means a new alternative for the users and estimating their reaction to the new infrastructure is complicated whereas an existing project has an historical track record of traffic. Moreover, the greater the number of transport alternatives the more sensitive the traffic demand will be. Finally, the more unstable the economy is, the more difficult it is to know how the key variables that determine traffic demand (such as value of time, land use and so on) are going to evolve.

Manipulated errors mostly depend on the incentives that the stakeholder who carries out the forecasts has to reach their goals. In other words, each stakeholder will manipulate the traffic presented in order to maximize the probability of reaching their objective. In this paper we postulate that traffic projections, particularly those conducted by the bidders, have relevant strategic errors stemming from the incentives that bidders have to win the tender. These incentives will be analyzed in the third section of this paper.

Traffic Accuracy in Transport Projects: Concessions vs. Public Procurement

The largest and geographically broader study dealing with forecasting accuracy for transport projects is the study conducted by Flyvbjerg et al. (2005). In this study 210 projects (27 rail

projects and 183 road projects) were analyzed in 14 countries. Most of the projects analyzed in this sample are publicly procured projects so the traffic projections analyzed were conducted by the government for most of the samples. The study reports substantial errors for both road and rail projects since the standard deviation of the road and the rail samples are quite similar. However, for road projects traffic is not overestimated on average whereas for rail projects the overestimation is notable. Flyvbjerg et al. (2005) point to strategic reasons to explain the acute difference between rail and road. They claim that as competition for funds is typically more pronounced for rail than for road, rail promoters have a greater incentive to inflate traffic projections.

Focusing our attention on roads, it is important to note that even though the average figures do not show a substantial bias (an underestimation is up to 8.7%), the errors are worth noting. For 50% of road projects, the difference between actual and forecast traffic is more than +/- 20%; for 25% of road projects, the difference is larger than +/- 40%. The study shows also that there is no significant difference between the inflated versus deflated forecasts for road traffic.

As Flyvbjerg et al. (2005) write in their paper, one of the main limitations of their survey was that they were unable to compare tolled versus free roads. This analysis could have yielded very interesting results since the public sector does not seem to have a big incentive as the private sector does to inflate traffic forecasts. The study finishes with an analysis of the causes that, according to the authors, might have prompted traffic inaccuracy. To that end, the authors conducted a state preferences survey in order to know the stakeholders' opinion. For rail projects, the two most important stated causes were "uncertainty about trip distribution" and "deliberately slanted forecast". However, for road projects, the two main causes were "uncertainties about trip generation" and "land use development".

In 2006, Naess, Flyvbjerg and Buhl carried out an analysis of traffic deviations in tolled versus free roads. However, this analysis was not very robust since the sample of toll roads was rather small. From the 7 toll roads sampled in Europe, an overestimation of 6.1% was reported whereas for a sample of 14 toll roads in the US an overestimation of 42% was reported. This analysis shows how, unlike the general road sample analyzed by Flyvbjerg et al. (2005) where most of the roads are free of charge, toll roads shows a trend toward overestimation.

Perhaps the most complete study dealing with traffic forecasting accuracy in PPP projects is the study conducted by Standard & Poor's which is periodically updated. Their 2005 study was conducted on the basis of 104 toll roads. The study reveals that forecasters show a bias towards overestimating first year traffic by 20%-30%. Beyond the first year, the study shows "Optimism bias and error measurement statistics remain constant through years 2-5" (Bain and Polakovic 2005). Moreover, the Standard and Poor study significant differences between forecasts by banks, sponsors and bidders. Bank-commissioned forecasts consistently appear to be less prone to large errors than those commissioned by project sponsors and/or bidders. Although, the Standard & Poor study has an investment/credit analysis perspective, the study found two important features of traffic forecasting for toll roads. First, toll-road projects with high levels of inherent uncertainty appear to be more susceptible to large forecasting errors. And second, the study showed that the stakeholder who has commissioned the traffic forecasts is key to explain forecast errors.

From the analysis of the literature regarding traffic accuracy we obtain several findings. First, traffic estimation errors are worth noting for both free and toll roads. The standard deviation of the samples analyzed for toll and free roads are substantial but they are higher for free roads 0.44 than for toll roads 0.25. However, toll road estimations show a significant bias

toward overestimation while free road estimations do not. Moreover, for toll road projects, the stakeholder who conducted the estimation has a big influence on the level of overestimation. All these results seem to explain that the “strategic error” is more relevant for PPPs than for publicly procured contracts.

MECHANISMS TO MITIGATE TRAFFIC RISK

The negative consequences of failing to manage traffic risk have spurred governments to develop and implement a wide range of traffic risk mitigation mechanisms. Across the spectrum of approaches, two common objectives are sought: first, increasing the completeness of concession contracts to reduce the potential for renegotiations; and second, establishing more equitable rules for sharing gains or losses between the PPP contractor, the government and the users. The traffic mitigation strategies adopted across the globe can be classified according to:

1. The trigger variable used.
2. The stakeholder that sets the limit or limits of the trigger variable used.
3. The extent to which risk is shared.
4. The compensation mechanism adopted.

Trigger Variables

The trigger variable is what initiates the traffic risk-sharing mechanism. When the trigger

variable stipulated in the contract reaches a certain level, the risk-sharing mechanism is activated. Three different types of trigger variables have been implemented to mitigate traffic risk in transportation concessions. The first are variables associated with the annual traffic, either volume or revenue. Both variables are strongly related since maximum tolls indexed to inflation are often established in transportation concession contracts. This set of trigger variables initiate the risk-sharing mechanism when the annual traffic or revenues obtained by the concessionaire falls below or above certain limits predefined in the contract. This mechanism has been most commonly implemented as “minimum income guarantees” in countries including Korea, Chile and Colombia (Irwin 2003).

The second group of trigger variables is linked to the accumulated traffic during the contract period of the concession. In other words, the risk-sharing mechanism is activated on the basis of a target to be reached before the concession ultimately ends. Unlike the annual guarantee approach described above, the government only compensates the concessionaire (or receives a rebate) if total traffic volumes fail to materialize (or exceeds anticipated levels). This approach avoids payments when annual fluctuations in traffic volume, that are exogenous to the concession, take place. This mechanism has not been extensively used; however, some countries—United Kingdom, Portugal, Chile and Colombia—have implemented this approach in some PPP contracts.

The third set of trigger variables address the financial performance of the concession company. Profit and internal rate of return (IRR) can be employed to monitor the concessionaire’s status. The use of these variables has the advantage that they accurately reflect the business performance of the concessionaire. However, the use of profits or IRR can be problematic for two reasons. First, the concessionaire has no incentive to reduce operating costs when its performance is close to the limit established in the contract. Second, profits or

IRR are difficult to monitor by the government because the public authority has limited access to accurate real operating costs incurred by the PPP contractor. This mechanism has been used in Spain and France.

A comparison of the three options reveals that the use of traffic and revenues (either annual or accumulated) as the trigger variable has two important advantages. First, unlike profits or IRR, the contractor has always a strong incentive to be efficient in reducing operating costs. Second, the government can easily monitor the trigger since tolls and traffic are readily verifiable.

Who Sets the Trigger Level?

The second criterion for classifying traffic risk mitigation techniques is who defines the threshold beyond which the risk-sharing mechanism is activated: the government in the bidding terms, or the concessionaire in the tender. For instance, a concession contract can establish an annual “minimum income guarantee,” but the precise limit of this guarantee can be defined either by the government or concessionaire. The government has defined the trigger level in highway concessions in Chile whereas the concessionaire has proposed the limits in two light rail concessions recently awarded in Madrid. Madrid’s light rail experience demonstrates that it is not adequate to give absolute freedom to the concessionaire to fix the “minimum income guarantee” threshold, since the concessionaire has an incentive to place this limit as high as possible which is more likely to lead to government compensation.

Sharing the Risk

The third criterion of the classification is the extent to which traffic risk is shared. This extent can be defined in two ways—a fixed target or a minimum/maximum band. The first option is to fix a specific target—a point—that has to be reached during the life of the contract, for instance a fixed project IRR, a fixed amount of accumulated revenues and so on. A second possibility is establishing a minimum and a maximum limit, in such a way that the risk-sharing mechanism be activated only as the actual trigger variable falls below the minimum limit or above the maximum limit. If the variable is in between these limits traffic risk totally falls on the concessionaire. A sub-classification within this second criterion differentiates whether the target limits are strict limits or not. A non-strict limit indicates that when traffic falls above (if it is an upper limit) or below (if it is a lower limit), the gains and losses are shared with the contractor. A limit is strict when there is no gain above the upper limit or loss below the lower limit for the concessionaire.

Compensation Mechanism

The fourth criterion for classifying traffic risk mitigation mechanism is the compensation scheme. Three different techniques have been employed: a subsidy from the government, a change in the level of tolls, and a modification of the length of the contract.

A subsidy from the government is the easiest way to compensate the concessionaire, but it has the drawback that it involves the future commitment of public resources, which can be a serious problem for countries with serious budgetary constraints.

Raising tolls if traffic is lower than expected, especially as a result of an economic downturn, has rarely been implemented in transportation PPP contracts for several reasons. First, it is

politically unpopular because users are required to pay more at a time when incomes are lower. Second, there is a risk that a toll increase will further reduce traffic due to the price elasticity of tolls. Third, it violates economic efficiency since pricing theory indicates tolls should be set according to marginal costs in line with traffic levels.

An alternative approach is extending the concession term to allow more time for the concessionaire to recoup its investment. This approach offers two attractive features. First, it does not commit public resources. And second, it does not generate the equity and efficiency problems that price modifications do.

All of the compensation systems described above can be further sub-classified according to the magnitude of compensation permitted in the contract. For instance, changes in toll levels or the duration of the concession can be unconstrained to ensure that the target financial goal is achieved. Alternatively, maximum limits for toll increases or extension of the concession can be specified in the contract. Contract limitations are most common.

Design and Assessment of Mitigation Strategies

The four classification variables have been combined in a variety of ways to create traffic risk mitigation strategies. The three most common strategies are: (1) “modification of the economic balance” of contracts; (2) traffic guarantee contracts; and (3) duration adjusted contracts.

The first approach, which was developed by France (Gomez-Ibañez and Meyer 1993; Shugart 1998) and recently adopted by Spain with some differences (Vassallo and Gallego 2005), consists of reestablishing the “economic balance” of the concession in case that the IRR falls

below a minimum IRR stipulated in the contract. In some cases, a minimum IRR is accompanied by a maximum IRR. The upper bound limits the concessionaire's profits if traffic is much higher than expected. Generally, the compensation measures to be adopted for re-establishing the economic balance of the contract are not pre-established but rather negotiated when the IRR falls above or below the target levels. Compensation can include change in toll levels, adjusting the contract length or the provision of public subsidies. Experience with this approach has revealed two major problems. Since the way to re-establish the economic balance of the contract is not fully specified, long and tedious renegotiations between the concessionaire and the government often occur. Also, the concessionaire has no incentive to reduce operating costs when the project IRR is close to the lower limit since falling below the limit permits a renegotiation of the contract. Overall, this mechanism has fulfilled the goal of increasing the interest of the private sector in concession contracts; however, it has been problematic because the agreements between the concessionaire and the government for re-negotiation may not yield net social gains.

The second approach—used in many countries such as Korea, Colombia, Chile, Dominican Republic, Malaysia—consists of guaranteeing either traffic or revenues. Failure to achieve the minimum level (specified by the public authority or the bidder) triggers compensation from the government. In many contracts the lower limit is often complemented with an upper limit above which the revenues are shared between the government and the concessionaire. The main problem of the guarantee approach that cannot be ignored is the strong correlation between traffic and economic growth; the guarantee can have very negative consequences for the public budget if a recession occurs. Nevertheless, the mechanism has worked quite well in some countries such as Chile where, even during an economic recession, only 4 out of 29 transportation concessions in operation at the end of 2004 performed below the minimum

income guarantee band. This meant a subsidy from the government of only 6.24 US\$ million compared to the 350 US\$ millions of investment (Vassallo and Sánchez Soliño 2006.) This mechanism has not worked so well in more unstable countries such as Colombia where traffic volume turned out to be lower than guaranteed levels for many concessions (Rufian 2002), which put a large strain on the government's fiscal position.

The third approach, which has been adopted in several countries recently, is to match the duration of the concession to a predefined target, usually related to traffic or revenues. This approach was first applied in 1990 in the concession of the Second Severn Crossing in the United Kingdom. Although initially the government decided that the maximum period for the concession should be no longer than 30 years, the concessionaire—Severn River Crossing Plc. —proposed the basis of the length of the concession be set on a “Required Cumulative Real Revenue” (Foice 1998). This way, a total project revenue was established in 1989 prices, which, once collected from tolls income, would end the concession. Based upon traffic levels during the early years of the concession, it was expected that the concession duration would be ultimately 22 years, considerably less than initially predicted. Another similar concession was awarded in Portugal at the end of the 1990's. The concession agreement was designed in order that the concession would expire no later than March 2028 or at a total cumulative traffic flow of 2,250 million vehicles (Lemos et al. 2004.) If the traffic is higher than expected the concession will finish earlier than 2028.

The best-known specification of this mechanism is called “Least Present Value of the Revenues (LPVR)” and has been extensively developed by Engel, Fischer and Galetovic (1997, 2001.) The authors of these papers working independently of the Severn Bridge experience developed this mechanism in response to a proposal by an official of the Chilean Ministry of Public Works (MOP). Under this mechanism, the concession is awarded to the

bidder who offers the least present value of the accumulated revenues—discounted according to a discount rate pre-fixed in the contract. The concession ends when this LPVR is reached. Consequently if the actual traffic is higher than expected, the concession will finish earlier whereas if it is lower the concession will finish later. Traffic risk is thus shared among the concessionaire, the users (who pay tolls for a longer period if the traffic is ultimately lower than expected), and the government (who receives the concession later if traffic is lower.)

The LPVR mechanism was tried in Chile; however, only two concessions out of 29 were successfully awarded under this approach. Vassallo (2006) showed that the main reason why this mechanism was less successful in practice than in theory was the strong opposition of the concession companies because of the risk profile. Since the contracts established a maximum duration, the concessionaire bore the risk that the project would not reach the LPVR requested before the end of the contract. Moreover, they were going to enjoy a small upside profit if the traffic were greater than expected because in this case the contract would end early.

Although LPVR has been dominantly implemented in Chile other countries have also adopted this technique. At the end 2004, Portugal decided to apply LPVR to a new toll highway concession, the “Litoral Centro” highway. The concession will come to an end when the net present value (NPV) of the total revenue collected reaches €784 million, subject to a minimum period of 22 years and a maximum period of 30 years. The so-called “third generation of concessions” carried out in Colombia implemented a similar mechanism based on awarding the contract to the bidder who requires the lowest accumulated revenues. The main difference of this mechanism compared to LPVR is that revenues are not discounted in this case. This way, the risk assumed by the concessionaire is greater when the trigger variable is the lowest accumulated revenues than the present value of the revenues.

PROCUREMENT, RENEGOTIATION AND TRAFFIC INNACURACY

Transport infrastructure facilities are far from having characteristics of perfect markets. Most of them endure market failures such as natural monopolies, public goods, and externalities. For instance, most infrastructure facilities have characteristics typical of natural monopolies because they work in the zone where marginal costs are lower than average costs. This fact explains why promoting competition in providing transport infrastructure had been so complicated and consequently many governments have often assumed the construction, maintenance and operation of facilities such as roads, railroads, airports and ports.

However, as many governments are bearing serious budgetary constraints, the participation of the private sector through different kinds of Public Private Partnerships (PPPs) is becoming fairly popular all around the world. Moreover, PPPs are regarded not only as a means for the government to release public funds but also as a way of promoting efficiency in the provision of public infrastructure. Most of these PPPs are based on a contract between the government and a private consortium to which the infrastructure is entrusted for a period of time established in the contract. Owing to the natural monopoly characteristic of many infrastructure facilities, it is not possible to promote “competition in the field” so governments are forced to promote “competition in the field”.

The competition in the field is based upon selecting the best consortium upfront through a tender. The government has the challenge of selecting the best consortium out of those who attended the tender on the sole basis of the information provided by the bidders on a piece of paper. This is the reason why designing an efficient procurement process that helps the government to choose the best consortium is key for the success of the contract.

In this section, we deal with the influence that the procurement process and the willingness to renegotiate by the government has in the traffic prediction errors that happen to be in PPPs. We presume that the combination of a competitive tender along with the willingness of government to renegotiate can end up causing a clear incentive for the bidders to inflate their traffic projections.

Procurement

There are several ways of procuring a PPP project. As a first approach, we can make a distinction between the “open procedure” and the “negotiated procedure”. The “open procedure” is founded on granting the PPP contract on the basis of the information made available by the bidders according to the requirements established by the government in the bidding terms. Consequently, in using the “open procedure”, the government takes the decision without meeting the bidders. This kind of tender is more common in countries where the civil law system predominates such as Spain, France and Latin America. The “negotiated procedure” is founded on a negotiation of the contract between the government and a few preferred bidders who are selected in a prequalification process. This process is more common in countries where the common law is applied such as the United Kingdom.

The “open procedure” has advantages and drawbacks compared to the “negotiated procedure”. Transaction costs in the “open procedure” are much lower than they are in the “negotiated procedure”. However, the definition of the contract is less perfect in the “open procedure” than it is in the “negotiated procedure”.

There are different kinds of open procedures according to the variables adopted by the government. First, we can make a distinction between open procedures that include and do

not include prequalification. Second, we can distinguish between “auctions” and “competitions”. Auctions are characterized by the fact that the contract is awarded to the cheapest bidder in terms of an economic variable pre-established in the bidding terms. Competitions however take into account both economic and technical variables which are weighed in order to obtain a final score. Under a competition approach, the contract is awarded to the bidders who reached the higher score according to the criteria set up in the bidding terms.

The procurement mechanism more often used in Spain is the “open procedure” without prequalification and on the basis of a competition in which both technical variables (such as final design, environmental measures, operation plan and so on) and economic variables are combined. In Chile, however, most PPP contracts are tendered on the basis of two stages: a prequalification stage and a subsequent auction over a single economic variable established in the bidding terms.

In this section, we develop a procurement model, which is focused on an open procedure awarded on the basis of an auction. The financial balance of a PPP can be established according to equation 1.

$$I_0(k) = \sum_{i=1}^{i=n} \frac{p_i \cdot q_i(p_i) - c_i(q_i, k)}{(1 + \theta_i)^i} \quad (1)$$

In this equation, p represents the price of using the PPP, q is the traffic volume, I_0 is the value of the initial investment, c is the maintenance and operation cost, and θ is the weighted average cost of capital. We assume that both I_0 and c depend on a parameter k , which shows the efficiency and productivity of the concessionaire.

In order to simplify equation (1) above, we assume that we can separate the numerator and the

denominator and take the denominator out of the summation. Under this assumption, we can rewrite equation (1) in the following way:

$$I_0(k) = R(\theta) \cdot \sum_{i=1}^{i=n} (p_i \cdot q_i(p_i) - c(q_i, k))$$

$$I_0(k) + R(\theta) \cdot \sum_{i=1}^{i=n} c_i(q_i, k) = R(\theta) \cdot \sum_{i=1}^{i=n} (p_i \cdot q_i(p_i)) \quad (2)$$

The right side of equation (2) shows the present value of the revenues whereas the left side of equation (2) shows the present value of the costs. Reorganizing some of the terms of equation (2), we obtain equation (3).

$$F(q_i, R(\theta_i), n, k) = \frac{I_0(k) + R(\theta) \cdot \sum_{i=1}^{i=n} c_i(q_i, k)}{R(\theta)} = \sum_{i=1}^{i=n} (p_i \cdot q_i(p_i))$$

$$F(q_i, R(\theta_i), n, k) = \frac{I_0(k)}{R(\theta)} + \sum_{i=1}^{i=n} c_i(q_i, k) = \sum_{i=1}^{i=n} (p_i \cdot q_i(p_i)) \quad (3)$$

At the right side of this equation is the summation of all the revenues that the PPP contractor expects to make all over the length of the contract. The right side of equation (3) shows the costs that depend on the effort of the contractor, the traffic each year, the period of the PPP contract, the weighted average cost of capital, and the efficiency of each operator. The contract length n is often established in the contract so it takes the same value for all bidders. Assuming that the contractor cannot influence the traffic level, for a specific PPP contract, q_i will be the same for all the bidders. This way, we arrive at the conclusion that F depends only on k and θ , which are inherent to each bidder. Consequently, we can define a function, which we call F that, according to the previous assumptions, depends mostly on the effort and

efficiency of each bidder in such a way that the greater the efficiency the lower the value of F .

Assuming that the tender is awarded to the bidder who offers the lowest toll, and assuming that this toll does not vary throughout the concession period, we can claim that the toll that each one of the PPP contractors will offer will be given by equation (3):

$$p = \frac{F_j(R(\theta_j), k_j)}{\sum_{i=1}^{i=n} q_i(p)} \quad (3)$$

Consequently, the toll p will depend on F and on the traffic predicted. In this equation, the subscript j refers to the different bidders who can attend the tender. Assuming that traffic growth is constant, we can claim that $\sum_{i=1}^{i=n} q_i(p) = g(q_1, p)$. According to this, we can rewrite equation (3) in the following way:

$$p = \frac{F_j(R(\theta_j), k_j)}{g(q_1, p)} \quad (4)$$

Figure 1 shows an example of a procurement process that is awarded on the basis of the lowest fare p . In a simplified way, we can represent the “effort functions” as curves that decrease with the level of traffic. We assume that two consortia are competing. Consortium A is more efficient than consortium B. The closest the effort function to the origin the more efficient the consortium is. Looking at Figure 1, it is clear how consortium A is more efficient than consortium B.

(Figure 1 app. here)

The left side of Figure 1 shows the case in which the two consortia expect the same traffic. In this case, consortium A will bid a lower price (p_A) than consortium B (p_B) so the most

efficient company will win the tender. For this case, the procurement process works quite well. However, if the less efficient company makes optimistic projections, because consortium B is not accurate or because it expects the government to renegotiate in the future, the government may award the concession to the less efficient consortium. This case is shown in the right graph of Figure 1.

This example is only a sign of the inefficient results that might happen in the procurement process as a consequence of the different traffic estimations coming from different bidders. This result comes from the assumption that traffic does not substantially depend on the effort of the contractor. A question regarding this issue becomes evident: should the tender require the bidders to submit their traffic projections if at the end the traffic only marginally depends on the contractor's effort?

To answer this question we found two approaches. The first one supports the view that bidders have to make their calculations on the basis of their projections. The second one says that the traffic estimated by bidders should not be taken into account since in the end traffic scarcely depends on the concessionaire's effort.

The first approach is based on three arguments: first, the higher the traffic the larger the operation and maintenance costs will be; second, the transference of traffic risk will encourage the concessionaire to have a greater traffic volume; and third, if the contractor makes optimistic estimations she will go bankrupt so she will have an incentive to make conservative projections. The two first approaches seem to be reasonable since the concessionaire should always have an incentive to have more traffic. The third one however is valid only if the government do not renegotiate.

Incomplete Contracts and Renegotiation

Contract theory makes a distinction between complete and incomplete contracts. According to Salanie (1997) a complete contract takes into account all variables that are or may become relevant throughout the life of the contract. Incomplete contracts, however, are those contracts for which it is impossible to allow for all the events that can occur throughout the life of the contract. As Bolton and Dewatripont (2004) claim, most long-term contracts are in practice incomplete since taking into account all the potential events that may result is in fact impossible. As PPP contracts are often long-term contracts, we can claim that most PPPs are closer to incomplete contracts than to complete ones.

In contract theory, there are two issues that are worth noting: commitment and renegotiation. Commitment refers to the ability of the stakeholders in a contract to constraint their actions by pledging that they will fulfill the contract until some predetermined date. Consequently, the duration of commitment determines how rigid the contract is. Salanie (1997) says that commitment is “full” when the contract is never reconsidered, and the dynamic aspects reduce to the execution of the contract. A commitment is “long term with renegotiation” if it can be renegotiated multilaterally. Renegotiation is the agreement ex-post between the parties that signed a contract in order to change one of the clauses of the contract. We have to distinguish renegotiation from an interpretation of the contract in order to solve an event which is not explicitly established in the contract.

If contracts are complete, a full commitment will be beneficial since the contract determines upfront the most adequate solution in the case that any event would eventually happen. As Salanie (1997) points out, when contracts are complete, the ability to renegotiate acts as an ex-ante constraint on the Principal’s program, and it will bring an efficiency loss.

However, complete contracts are rather illusory. In the real world, the cost of taking into account an improbable contingency outweighs the benefit of writing a specific clause in the contract. Moreover, in some cases courts are not able to verify the outcome of certain variables which are key for the contract. These reasons among others justify that most of the contracts, particularly long-term contracts, are to be considered incomplete contracts. Unlike complete contracts where renegotiation is not efficient, renegotiation in incomplete contracts can be efficient.

The word renegotiation usually has a negative connotation. However renegotiations do not have to be necessarily bad since they can increase the welfare of all the stakeholders involved in the contract when the contract is incomplete. In this case, the renegotiation is Pareto optimal. A renegotiation is efficient but not Pareto optimal when it increases the social welfare but not the welfare of each one of the stakeholders. Finally, a renegotiation is inefficient when it decreases the social welfare.

Guasch (2004) demonstrates that concession and PPP contract renegotiations are quite common all around the world. Guasch's study focuses on Latin American concession contracts in several sectors: telecommunications, energy, transportation, water and sewage. His study shows that 54.7% of the transportation projects in the sample were renegotiated. The study also shows that renegotiation is prompted not only by the concessionaire but also by the government. The concessionaire initiated 57% of the renegotiations in the transportation sector while 27% and 16% were started by the government and by common agreement respectively.

Guasch's study also shows that renegotiations are much more common in those concessions awarded competitively than in those concessions awarded through direct negotiation. This

result can be interpreted as an empirical explanation of what is called “the winners curse” (Capen, Clapp and Campbell 1971) where aggressive bids associated with inflated traffic forecasts lead to low bids by the concessionaire.

Does procurement and renegotiation have to do with the inaccuracy of traffic estimations?

In the first section of this paper, we mentioned that traffic estimation errors may be split into “natural errors” and “strategic errors”. We said that “natural errors” do not depend on the strategic behavior of the bidders and consequently does not depend on the procurement mechanisms used for PPP contract tendering. However, we postulated that the procurement mechanisms used to tender a PPP contract along with the government’s willingness to renegotiate can cause the concessionaire to inflate traffic forecasts.

In this section, we establish that the “strategic error” is a function of four variables: first the competitiveness of the tender, which depends on the procurement mechanism adopted and the number of bidders that are expected to tender; second, the completeness of the contract, which in turn depends on the procurement mechanism adopted; third, the willingness to renegotiate by the government; and fourth, the traffic risk mitigation mechanisms adopted in the contract if any.

The more competitive a tender is the greater is the incentive of the concessionaire to inflate traffic forecasts in order to have any chance of being granted the concession. Competitiveness in a tender depends on the expected number of bidders and the procurement mechanism adopted. The larger the number of expected bidders the greater the incentive of each individual bidder will be to inflate traffic forecasts to win the tender. Moreover, the

procurement mechanism adopted determines the competitiveness. For instance, an open procedure seems to be more given to inflated traffic forecast than a negotiated procedure since the economic variables are often more relevant there. Moreover, an open procedure based on an auction seems to be more prone to “strategic errors” than a procedure based on competition.

The completeness of the PPP contract is also important to determine the extent of the strategic error. The more complete a PPP contract is the lower the probability of renegotiation in the future, and consequently the lower the bidders’ incentive to commit strategic errors. Similarly, the willingness to renegotiate by the government is crucial for the bidders in their decision to inflate or not traffic forecasts. If a government is willing to renegotiate, it is implicitly encouraging to bid aggressively under the hope of a future renegotiation.

The main reasons why governments are willing to renegotiate generally lies in their intention to keep their reputation. This situation may cause a “vicious cycle” in the concession tender since competition to be awarded concession contracts is fierce (see Figure 2). This “vicious cycle” explains why, if governments show a historical track record of renegotiation, bidders will be encouraged to inflate their traffic forecast to justify aggressive offers in order to increase their possibilities of winning the tender. Once the contract is secured, the concessionaire assumes the government will renegotiate the agreement if traffic is lower than expected. Unfortunately, the government often agrees to renegotiate to preserve its reputation which in turn sets a bad precedent and encourages future “low ball” offerings.

(Figure 2 app. here)

The last issue is whether a traffic risk mitigation mechanism has been implemented in the contract or not. The implementation of a traffic risk mitigation mechanism such as the LPVR,

for instance, discourages bidders to present inflated traffic forecast since the ultimate outcome of the concession is independent of the traffic predicted by the concessionaire. Consequently, under this approach, the concessionaire has scarce incentive to make inflated traffic predictions. Other traffic risk mitigation mechanisms such as the minimum income guarantee depend on how they are defined in the contracts. If the threshold is independent on the concessionaire predictions, the concessionaire does not have much incentive to inflate traffic forecasts. However, if the thresholds depend on the concessionaire predictions, the concessionaire has still a great incentive to inflate traffic forecast to place the threshold at the highest level.

In brief, we postulate that “strategic errors” mostly depend on how the tender is defined and how willing is the government to renegotiate. Consequently, acting on these two issues may help bidders to present more realistic offers.

CASE STUDY: CONCESSION CONTRACTS IN SPAIN

The aim of this last section is to contrast the assumptions previously made with empirical results. Unfortunately, it has been impossible for the authors to gather enough data to carry out a more accurate statistical analysis. This is the reason why in the last section we are testing the hypotheses previously approached on the basis of the case study of highway concessions in Spain where data were available.

Brief History

Spain has long experience in the implementation of toll motorway concessions. This fact has

prompted the passage of specifically relevant laws throughout these years. The first legislation passed in Spain was mainly concerned with motorway concessions, and did not include other kinds of public infrastructure. Recent legislation broadened the scope of concessions to other kinds of infrastructure. Figure 3 shows that, since 1967, the Spanish Central Government has granted 32 motorway concessions. In 2006, a total of 2,700 km were awarded and 2,300 km of that total were already in operation.

There are three different periods in the history of toll motorway concessions in Spain (Vassallo and Sánchez, 2006): from 1967 to 1975, from 1976 to 1995, and from 1996 to 2005. Each one of these periods entailed significant legal reforms. From 1967 to 1975, 15 motorway stretches were awarded, which means almost 50% of the concessions granted in Spain up to date. The first set of toll motorway concessions were awarded through specific legislation approved by the government for each concession. The toll motorway regulation became much more stable in 1972 when the Toll Motorway Concession Law (*Ley 8/1972 de Autopistas en Regimen de Concesión*) was passed by the Spanish Parliament. This Law allowed motorway concessions to enjoy several advantages compared to other industries; these included loan guarantees, and exchange insurance provided by the State for those loans denominated in foreign currencies. These guarantees turned out to be very costly with the rise of gas and diesel prices, a result of the two oil price hikes of 1973 and 1979. These caused traffic growth to be lower than expected and currency exchange rates became unstable.

The second period lasted from 1976 to 1995. This period coincided with a historical stage well-known in Spain as the “transition to democracy”, which took place after Franco’s death. During this period, mostly by a government under the Socialist Party, infrastructure funding policy in Spain changed radically. The socialist government was reluctant to implement toll concessions (see Figure 3) for two reasons. First, there was the negative experience derived

from the effects public guarantees in concessions had caused to the public budget. And second, there was the socialist government's conviction that road transport should be free of charge. Instead of toll motorways, the socialist government opted for modernizing the Spanish road network by widening and upgrading the most important roads, turning them into double-track fast lanes with quality standards well below those for toll motorways. In 1988 a new Law, the Roads Law (*Ley de Carreteras*), was passed by the Spanish Parliament. This law did not really consider motorway concessions, but it abolished some advantages included in the Toll Motorway Concession Law of 1972 such as government loan guarantees and the government exchange rate insurance.

(Figure 3. app. here)

The third period lasts from 1996 to 2005. During this period including the present time, the European Union has been forcing its member states to comply with strict convergence criteria (public deficit, inflation, interest rates, and so on) if they wished to join the Euro single currency. This was the reason why the Popular Party carried out a substantial reform concerning the funding of infrastructure. The first aim of these measures was to recover macroeconomic stability in Spain without constraining infrastructure investment by reactivating the concession model. Between 1996 and 2004, fifteen new concession motorway stretches were awarded. This new trend towards private funding was reinforced by a new Public Works Concession Law, passed in 2003, which widened and updated the old Toll Motorway Concession Law passed in 1972. The objectives of this Law were, among others, to update the old motorway concession model and extend it to every type of public works (courts, prisons, hospitals and similar structures), to reinforce the contribution of private financing for constructing and maintaining public facilities, and to improve the legal framework by defining a new risk-sharing approach (Vassallo and Gallego, 2005). In 2004,

the Socialist Party was once again elected to government. Unlike what happened a few decades before, they decided to incorporate the concession mechanism in its program as a means of financing public infrastructure.

Renegotiation of Concession Contracts in Spain

Concession contract renegotiations have been common in Spain. The aim of these renegotiations was mostly to re-balance the economics of the concession, so as to allow for additional investments imposed by the government, modifications of the tolls contractually agreed in the contract, or to take into account actual traffic levels that turn out to be much lower than what was expected. Very often, these renegotiations have implied substantial extensions of the pre-established duration of the original contracts. In some cases, contract extensions have meant a doubling of the length of the concession originally agreed in the contract. This has happened, for instance, in four concessions in Spain (Montmeló–El Papiol, Burgos–Armiñón, Sevilla–Cádiz and Bilbao–Zaragoza).

Baeza (2007) conducted an interesting analysis about renegotiation of concession contracts in Spain. She found that 55% of highway concession contracts were renegotiated. Half of those concession contracts which were ultimately renegotiated were done during the first five years after the contract were granted. Regarding the causes, only 45% of the renegotiations were attributed by the government to a specific cause. The rest of the renegotiations (55%) were not attributed by the government to any specific cause. The most common renegotiation cause, among those which are explicitly mentioned in the renegotiation documents, is a change in the transport policy prompted by the government. Of the renegotiations, 50% ended up with toll rises, and 24% with extension of the concession periods.

This information enables us to presume that many renegotiations in Spain have often been prompted by a shortage of revenues caused by too optimistic traffic forecasts. As concession contracts in Spain are awarded on the basis of competitive procurement, bidders often play the strategy of bidding aggressively in order to be granted the concession, no matter how slim the likely profit, in the hope, and expectation, that the government will be willing to renegotiate in the near future. This way, the bidders have tended to inflate traffic forecasts to justify their own initial, and quite aggressively-priced financial offers. This behaviour, which corresponds to the “vicious cycle”, described above, has been unfortunately fairly common in motorway concessions in Spain.

The legislators, conscious of the renegotiation problems caused by many toll motorway concession contracts, decided to implement a mechanism to mitigate traffic risk. This mechanism was defined in the 2003 Public Works Concession Law (Vassallo and Gallego, 2005). One of the first objectives of implementing this mechanism was to limit renegotiations to specific events agreed upon in the contract, and to discourage initial bids that were wildly optimistic and therefore obviously very likely to need to be renegotiated later on.

Research Methodology and Empirical Analysis

Objectives and Methodology

The main goal of this research is to analyze the behaviour of traffic deviations (actual traffic compared to the traffic declared by the concessionaire in its offer) in toll motorway concession contracts in Spain, particularly the first few years of operation of the concession (the ramp-up period). During this period, the users are getting used to the new infrastructure so traffic growth turns out to be unusually high. The end of the ramp-up period occurs

when traffic stabilizes and becomes more in line with traffic patterns observed in other comparable roads (Bain and Wilkins, 2002).

First, we studied traffic overestimation in toll motorway concessions in Spain. According to our hypotheses, we would expect that concessionaires overestimate traffic due to the demonstrated willingness by the Spanish Government to renegotiate. Second, we wanted to discover the behaviour of the deviations throughout the first three years of the concession. Three, we considered the question whether the trend towards overestimating traffic follows a similar pattern in all the concessions. And fourth, we attempted to study the behaviour of traffic growth rates during the ramp-up period. This research is useful for several reasons. First, it could confirm the hypothesis that the government's willingness to renegotiate together with a competitive tender can encourage traffic overestimations. And second, it enables us to know the traffic behaviour of greenfield motorway concessions during the ramp-up period.

The methodology used in this research is based on comparing actual traffic with the traffic declared by the concessionaire in motorway concessions in Spain. To that end, two indicators are defined. The first indicator, which we call "Annual Traffic Deviation", shows the level of estimation, whether over or under, of actual traffic in year t compared to the traffic declared by the concessionaire in year t. This indicator is calculated with equation (4).

$$AD_t^j = \frac{RY_t^j - FY_t^j}{FY_t^j} \cdot 100 = \left(\frac{RY_t^j}{FY_t^j} - 1 \right) \cdot 100 \quad (4)$$

where:

AD_t^j : Annual traffic deviation for year t and concession j

RY_t^j : Real traffic intensity (annual average daily traffic in year t for concession j)

FY_t^j : Declared traffic intensity (annual average daily traffic in year t for concession j)

If $AD_t^j > 0$, traffic predictions were underestimated whereas if $D_t^j < 0$, traffic predictions were overestimated.

The second indicator, which we call “Traffic Growth Rate Deviation”, estimates the difference between the real and the forecasted annual traffic growth rates. Equations (5) and (6) show the way in which the real and the estimated growth rates are calculated. Equation (7) shows how the “Traffic Growth Rate Deviation” is calculated for the growth rate between year t and year t+1 and for concession j.

$$R\delta_{t/t+1}^j = \frac{RY_{t+1}^j - RY_t^j}{RY_t^j} \cdot 100 \quad (5)$$

$$F\delta_{t/t+1}^j = \frac{FY_{t+1}^j - FY_t^j}{FY_t^j} \cdot 100 \quad (6)$$

$$GR_{t/t+1}^j = R\delta_{t/t+1}^j - F\delta_{t/t+1}^j \quad (7)$$

If $GR_{t/t+1}^j < 0$, this means that the actual annual growth rate from year t to year t+1 was lower than expected. If $GR_{t/t+1}^j > 0$, this means that the actual annual growth rate in year t was higher than expected.

Data

The actual Annual Average Daily Traffic (AADT) for each concession was easily obtained from the databases that are published every year by the Secretary of Public Works (*Ministerio de Fomento*) of the Government of Spain. The last issue of this publication includes data up to 2005. This is the reason why this research compares traffic flows until 2005.

However, it was much more complicated to obtain the estimated traffic information since this information is included in the financial plans that were submitted by the bidders to the government in the tender. Thanks to the collaboration of the Concession Unit of the Secretary of Public Works, we were able to look at the financial plans presented by each one of the concessionaires. These financial plans included, in some cases, predicted the traffic. Due to the difficulty in gathering this information, this is the first time that an analysis of this type was conducted for toll motorway concessions in Spain.

We were not able to collect traffic data from all the concession contracts awarded in Spain. Ten financial plans submitted by the concessionaires, especially the oldest ones, are not available. Three concessions (Villalba – Villacastin, Villacastin – Adanero and Bilbao – Behobia) did not include traffic estimations in their financial plans. And five concessions did not start their operation in 2005. This is the reason why our database was only able to deal with 14 motorway concessions out of the 32 already granted in Spain. It is important to point out that all the motorway concessions included in the sample were awarded before the 2003 Concession Law was passed by the Spanish Parliament. Consequently, in these concession contracts, no traffic risk mitigation mechanism was included.

Table 1 shows a classification of the number of concessions analyzed, sorted by the political party then in power, and the legislation applicable when the concession was awarded. From

an overall view, the sample data covers 43.75% of the whole population, which is a good representation. It is interesting to note that the representation of the sample is particularly good for concessions awarded by the Popular Party under the 1972 Toll Motorway Concession Law.

(Table 1 app. here)

Results

Figure 4 shows the evolution of the annual traffic for the Tarragona – Valencia concession, which is the one in our sample with the longest track record. The trend towards overestimation that can be observed in this Figure represents quite well what happened in many concession contracts in Spain. This concession started its operation several months before schedule, but the level of traffic during the first year was much lower than expected. We wondered how the concessionaire was able to survive with a level of traffic that was barely 50% of what was predicted. The answer is that the concession was renegotiated several times throughout the years due to, among other reasons, its low level of traffic. As a consequence of these renegotiations, the duration of the concession was extended twice. The length of the original concession, agreed to in the contract, was 26 years. Right now, the current concession duration has been extended to a period of 45 years.

(Figure 4. app. here)

Table 2 shows annual traffic deviations (AD_t^j) and traffic growth rate deviations ($GR_{t/t+1}^j$) for the 14 concessions in the sample. Annual traffic deviations were estimated for the first three years of operation for each one of the motorways in the sample. Figure 5 shows in graph form

the evolution of annual traffic deviations in the ramp-up period for those concessions for which data was available for the three first years. Traffic growth rate deviations were estimated for both the growth rate between year 1 and year 2, and for the growth rate between year 2 and year 3.

(Table 2. app. here)

The annual traffic deviations show that 13 out of the 14 concessions analyzed overestimated traffic during the first year of the concession and during the ramp-up period. On average, for the first year traffic was overestimated by approximately 40%. In other words, real traffic during the first year of the concession was around 60% of what was declared by the concessionaires. We observe how this trend towards overestimation of traffic is also common for the second and the third years of the concession. This fact shows how there is a clear bias towards traffic overestimation in the ramp-up period. We believe that the main cause of this trend has to do with the perverse incentive created by the “vicious cycle” shown in the first part of this paper.

However, annual overestimation seems to diminish throughout the second and the third year. Comparing the ten concessions for which we have data for the first three years (see the row mean for 10 concessions), we see how the average overestimation decreases from -35.18% in the first year to -31.34% in the second year and to -27.06% in the third year. We presume that the cause of this lies in the difficulty of knowing the user’s reaction in the very first year of operation of a greenfield motorway. Once a project is factored into the users’ daily calculations, the deviations tend to be smaller.

Looking at the standard deviations of AD_t^j for years 1, 2 and 3, we find that it increases throughout the years. This means that traffic deviations of the concessions are closer to each

other in year 1 than in year 2 and year 3. In fact, for the ten concession sample row SD for ten concessions), the standard deviation is 27.93% for year one, 33.84% for year 2 and 35.01% for year 3. This means that, even though the further into the future from the year under discussion, the better on average is the initial prediction, the further the year, the more different is the behaviour of the concessions in the sample.

Analyzing the behaviour of traffic growth rates deviations ($GR_{t/t+1}^j$), Table 2 shows how, unlike annual traffic, on average, traffic growth rates are mostly underestimated (4.57% for the 1/2 growth rate and 8.32% for the 2/3 growth rate). However, for this indicator, the behaviour of deviations was not as clear cut as annual traffic deviations. From year 1 to year 2, seven concessions underestimated traffic growth rates and six concessions overestimated traffic growth rates. From year 2 to year 3, seven concessions underestimated traffic growth rates and three concessions overestimated traffic growth rates.

Regarding the standard deviations of $GR_{t/t+1}^j$, we obtained several findings. First, those deviations are smaller than the standard deviations of AD_t^j so the behaviour of the concessionaires in predicting traffic growth rates is more stable than in predicting traffic volumes. And second, the standard deviation for $GR_{2/3}^j$ is lower than for $GR_{1/2}^j$ so the longer the period under discussion, the more similar the behaviour among the set of concessions analyzed seems to be.

CONCLUSSIONS AND FURTHER RESEARCH

The following conclusions are reached on the basis of this research.

- Traffic projections presented by bidders for highway PPP contracts show a notable bias towards overestimation compared to the projections conducted by governments in publicly procured projects.
- This lack of accuracy in traffic projections is leading many governments to implement traffic risk mitigation mechanisms with a twofold objective: to limit traffic risk and reduce renegotiation pressure in the future.
- The forecasting errors committed can be split into two types: “natural errors” and “strategic errors”. Natural errors are caused by the lack of precision in the model whilst strategic errors are intentionally introduced by forecasters in order to have a bigger chance of reaching their objectives.
- We establish that “strategic errors” are motivated by the competitiveness of the tender; the incompleteness of the contract, which in their turn depends on the procurement mechanism adopted; the willingness to renegotiate by the government; and the lack of mechanisms to mitigate traffic risk in the contract.
- The results above were tested in Spain where renegotiations of concession contracts have been quite common. In some cases, these renegotiations prompted long extensions of the duration agreed upon in the original concession contracts. The willingness to renegotiate by the government, along with competitive tendering, seems to have encouraged aggressive offers and consequently traffic overestimations.
- The empirical data used in Spain shows that there is a clear bias towards overestimating traffic in the ramp-up period for toll motorway concessions. On average, actual traffic was substantially overestimated (approximately -35%) in the ramp-up period. This result is

consistent with the results found in other studies, such as the one periodically conducted by Standard & Poor's.

- Although the trend toward overestimation shown in the previous paragraph may be valid as an average, we observe that the deviations vary substantially among concessions—one concessionaire even underestimated traffic by 30% the first year. This fact is corroborated by the great variance of the distribution of the annual traffic deviations, which, depending on the year, ranges between 25% and 35%. This result, which is consistent with the literature, confirms that it is not possible to use the average overestimation rate obtained in this study to correct the accuracy of traffic estimations for individual projects.
- Counter intuitively, the longer into the future the year for which estimates are being made, the better the traffic predictions seem to be, or, in other words, traffic predictions seem to be less accurate the first year of operation of motorway concessions. This fact may be caused by the difficulty in knowing the behaviour of users during the very first year of a new motorway being opened.
- The traffic growth rate deviations are mostly positive so, unlike annual traffic deviations, traffic growth rates are mostly underestimated by concessionaires in the ramp-up period. This result is consistent with the fact that annual traffic deviations tend to diminish throughout the first years of operation. Moreover, the behaviour of traffic growth rate deviations seems to be much more homogeneous among concessions, compared to annual traffic deviations.

We postulate that the main reason why on average traffic is substantially overestimated in toll motorway concessions in Spain has to do more with the strategic behaviour of bidders in the tender, who declare traffic levels higher than they actually estimate, than with modelling

issues.

To solve this problem, three courses of action could be adopted. The first one is to include in the legislation specific limits to the renegotiation of concession contracts in order to prevent the government from negotiating as they want. The second course of action is to set up mechanisms to mitigate traffic risk in order to reduce the importance of traffic in the performance of the concession. A third measure could address reducing competition in the tender. However, we think that this latter measure is not suitable since competition is always good to promote efficiency.

According to the recommendations in the paragraph above, we would expect that after the implementation of the 2003 Public Works Concessions Law, traffic overestimation in concession contracts in Spain should diminish. This Law includes the possibility of implementing mitigation mechanisms for traffic risk in concession contracts, and limits the causes of renegotiation to a very few specific circumstances. Unfortunately, the first set of concessions under this Law were awarded in 2004 and 2005, and the motorways are still under construction, so no traffic data is available yet to make this comparison. Undoubtedly, this analysis will be interesting as an ongoing research.

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Table 1: The Analyzed Concessions Compared with the Awarded Concessions and Classified According to Legislation Period and Political Party in Government

		Concessions analyzed	Concessions awarded	Percentage
Political Party in Government	Dictatorship	2	15	13.33%
	Socialist Party	1	2	50.00%
	Popular Party	11	15	73.33%
	TOTAL	14	32	43.75%
Legal period	Before 1972 Act	1	7	14.29%
	1972 Act	13	24	54.17%
	2003 Act	0	1	0.00%
	TOTAL	14	32	43.75%

Table 2: Summary of Results

Concession j	Year of Awarding	AD_t^j			$GR_{t/t+1}^j$	
		t= 1	t= 2	t= 3	t= 1 / t+1=2	t= 2 / t+1=3
Tarragona-Valencia	1971	-37.73%	-45.21%	-45.74%	-14.20%	-1.11%
Valencia-Alicante	1972	-75.30%	-75.93%	-69.17%	-3.08%	27.43%
Málaga-Estepona	1996	-45.34%	-28.38%	-17.92%	32.44%	15.26%
Estepona-Guadiaro	1999	27.06%	45.98%	53.97%	15.59%	5.73%
Alicante-Cartagena	1998	-16.91%	-4.85%	1.33%	15.33%	6.86%
R-3	1999	-60.68%	-53.40%	-	19.66%	-
R-5	1999	-63.91%	-61.90%	-	6.02%	-
Santiago-Alto de Santo Domingo	1999	-44.60%	-35.27%	-37.24%	17.41%	-3.18%
Ávila-Villacastín	1999	-33.73%	-25.72%	-20.00%	12.53%	7.98%
Segovia-El Espinar	1999	-31.32%	-33.70%	-32.77%	-3.60%	1.46%
León-Astorga	2000	-28.13%	-44.04%	-45.60%	-24.96%	-3.01%
R-2	2000	-65.81%	-66.28%	-57.43%	-1.72%	25.77%
R-4	2000	-58.55%	-59.20%	-	-1.67%	-
Eje aeropuerto	2002	-62.94%	-	-	-	-
Mean (14 concessions)		-42.71%	-	-	-	-
Mean (13 concessions)		-41.15%	-37.53%	-	5.37%	-
Mean (10 concessions)		-35.18%	-31.34%	-27.06%	4.57%	8.32%
SD (14 concessions)		26.34%	-	-	-	-
SD (13 concessions)		26.74%	31.63%	-	15.52%	-
SD (10 concessions)		27.93%	33.84%	35.01%	17.10%	11.17%

Figure 1: Procurement Model under Different Traffic Assumptions

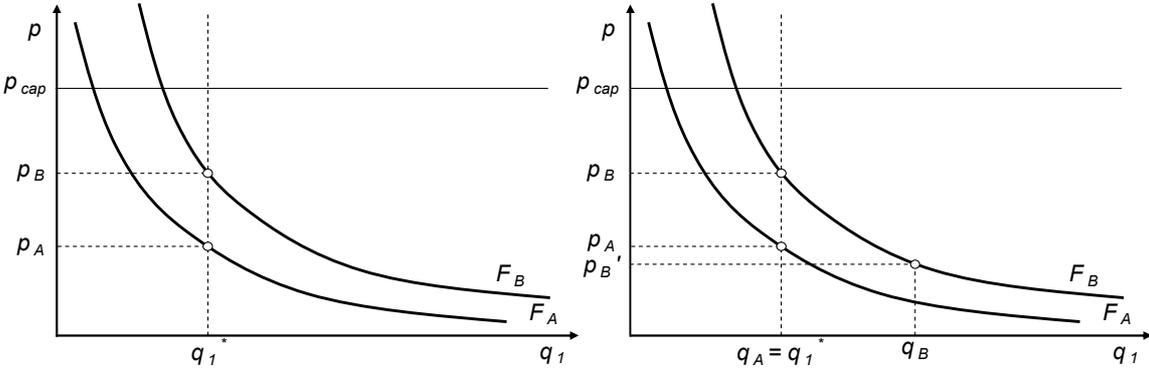


Figure 2: Vicious Cycle of Awarding Concessions when the Government Shows Willingness to Renegotiate

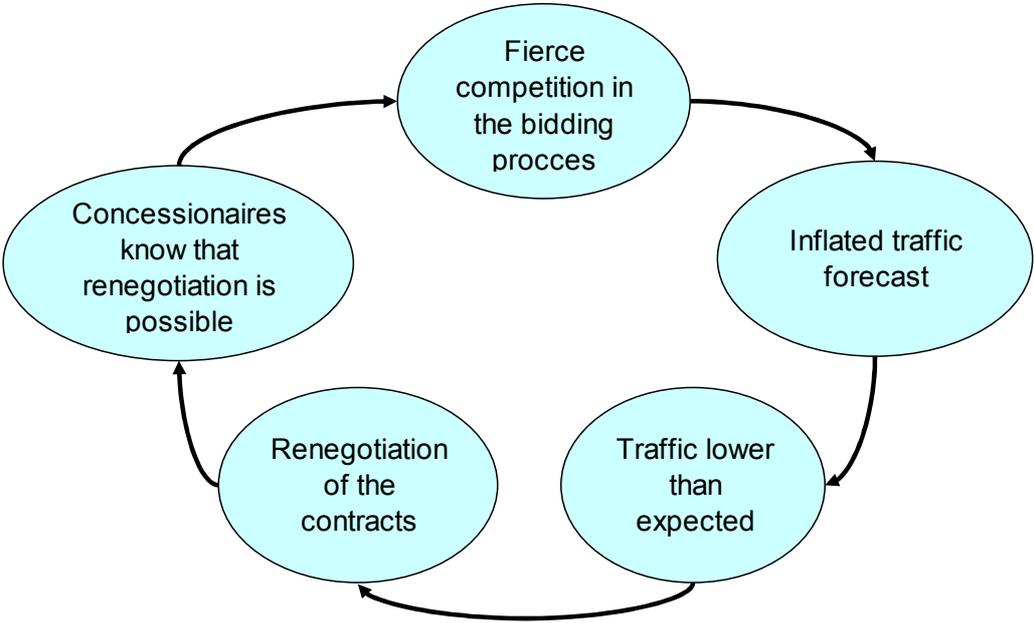


Figure 3: Number of Toll Motorway Concessions Granted by the Central Government in Spain from 1967 to 2006

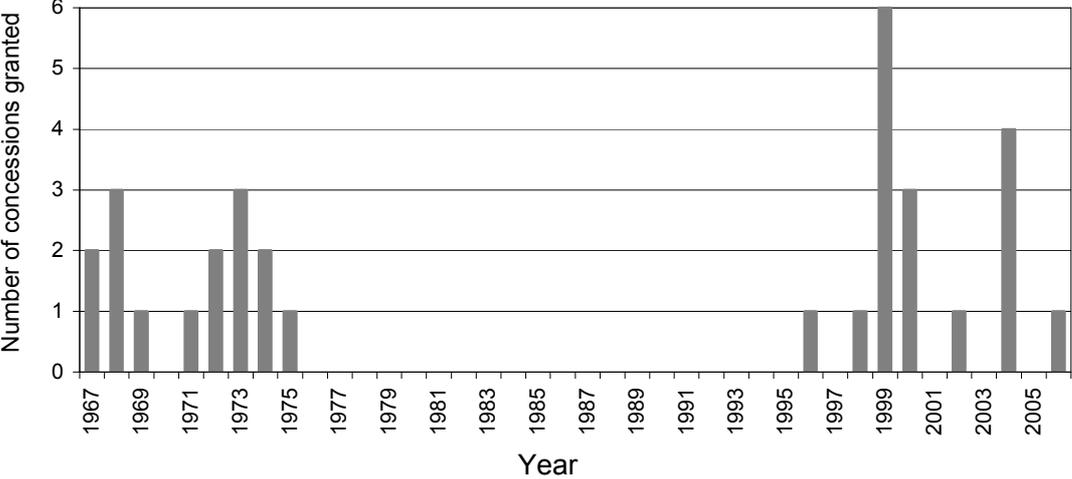


Figure 4: Annual Traffic Evolution for the Tarragona-Valencia Motorway

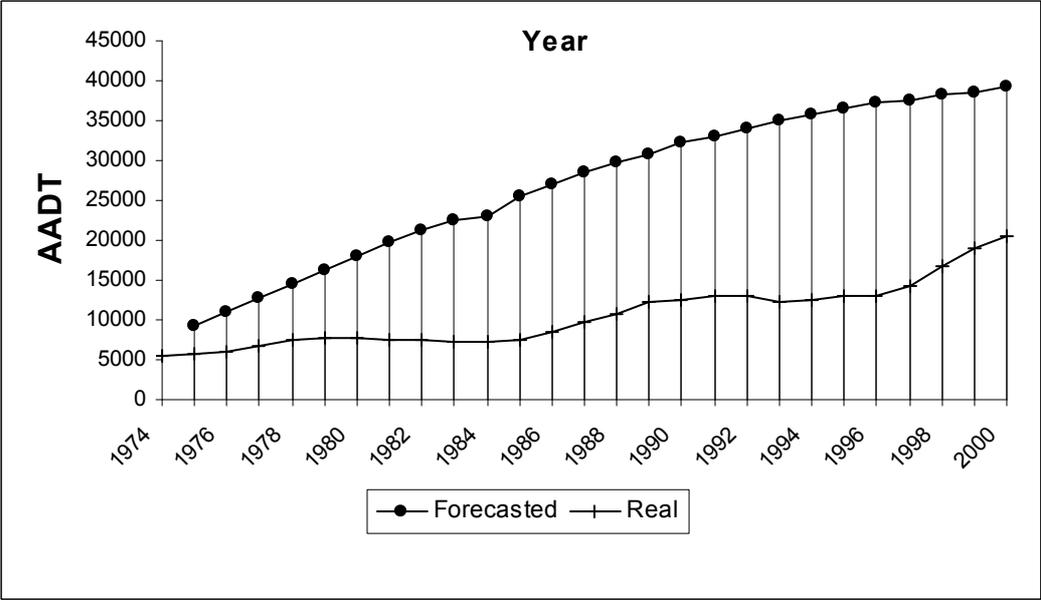


Figure 5: Annual Traffic Deviations in the Ramp-up Period for Eight Concessions of the Sample

