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Sources of Errors and Biases in Traffic Forecasts for Toll Road Concessions

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Number of Bidders, Information Dispertion, Renegotiation and Winner's Curse in Toll Road Concessions [1], [2]

[1]We gratefully acknowledge comments and suggestions from Claude Abraham, David Azema, Steven Berry, Luis Cabral, Eduardo Engel, Antonio Estache, Elisabetta Iossa, Philip Haile, Gabriel Jacondino, Rui Manteigas, Rui Montero, Homero Neves, Charles Paradis, Vincent Piron, Maher Said, Stéphane Saussier, Karl Schlag, François Tcheng, Jose Vassallo, Anne Yvrande, and participants at the European Group of Public Administration (EGPA) Conference, Milan, September 6-9 2006, 24th Pan-American conference on Traffic and Transportation Engineering, Spain, September 20-23 2006, 5th conference WIP, Berlin, October 06-07 2006, the ATOM and ADIS Research seminars, the CEPR-EBRD conference, "Partnerships between Government and Private Sectors", London, 22-23 February 2007, the Prospectus Workshop in Industrial Organization, Yale University, February 27 2007, the 5th IIOC annual conference, Savannah, USA, April 14-15 2007, the 62nd annual congress of the ESEM (European Meeting of the Econometric Society), Budapest, August 27-31 2007, and the 56th annual congress of the AFSE, Paris, September 19-21 2007.

[2]A short version of this chapter was accepted to the Economics Letters

Abstract

We empirically assess the effects of the winner's curse in auctions for toll road concession contracts. Such auctions are common-value auctions for incomplete contracts prone to pervasive renegotiations. We address three questions in turn. First, we investigate the overall effects of the winner's curse on bidding behaviour in such auctions. Second, we examine the effects of the winner's curse on contract auctions with differing levels of common-value components. Third, we investigate how the winner's curse affects bidding behaviour in such auctions when we account for the possibility of renegotiation. Using a unique, self-constructed, dataset of 49 worldwide road concessions, we show that the winner's curse effect is particularly strong in toll road concession contract auctions. Thus, we show that bidders bid less aggressively in toll road concession auctions when they expect more competition. In addition, we observe that this winner's curse effect is even larger for projects where the common uncertainty is greater. Furthermore, we show that the winner's curse effect is weaker when the likelihood of renegotiation is higher, *i.e.* bidders will bid more strategically in weaker institutional frameworks, in which renegotiations are easier.

3.1 Introduction

Competition for the field, or franchise bidding, has become increasingly popular to expand private participation in the provision of infrastructure services. Under such auctions, the State or a representative (local public authorities) awards an exclusive contract to the bidder offering the lowest price after an ex ante competition. Since the seminal paper by Demsetz (1968), this policy option has been considered as a tool of government to allow private sector participation and benefit from efficiency advantages of competition while retaining some degree of control and guaranteeing the respect of community service obligations (Baldwin and Cave, 1999; Engel et al., 2002). The fact is that in the last couple of decades, many countries have promulgated directives on public procurement so as to bring in competitive tender mechanisms, e.g. the Federal Acquisition Regulations' mandate to use auctions in the U.S. public sector, the 1989 European directive on the obligation of competitive tendering, the 1988 Local Government Act in the United Kingdom or the 1993 "Sapin Act" in France.

The main economic literature emphasizes that the efficiency of this awarding procedure depends on the number of bidders. Nevertheless, the optimal number of bidders will depend on the exact structure of demand and information (Athey and Haile, 2007).

According to the Walrasian analogy of markets as auctions, an increase in the number of bidders should encourage more aggressive bidding, so that in the limit, as the number of bidders becomes arbitrarily large, the auction approaches the efficient outcome. But, while this may be true in private value auctions[3] ,*i.e.* for auctions in which a bidder's estimate is affected only by his own perceptions and not by the perceptions of others, it has been shown that it may not be true in common-value auctions in which the competing bidders are differentially (but incompletely) informed about the value of the auctioned item. If bidders shared the same information, they would equally value the item of the auction. [4]

[3]Even though Pinkse and Tan (2000) and Compte (2002) challenged this traditional view respectively in affiliated private-values models and in private-values models with prediction errors.

[4]Consider a bidder i of an auction who has a cost c_i associated with completing the project being auctioned. This bidder receives a private signal x_i about c_i . In the pure

A distinctive feature of common-value auctions is the winner's curse, an adverse-selection problem which arises because the winner tends to be the bidder with the most overly-optimistic information concerning the value (the first formal claim of the winner's curse was made by (Cappen et al., 1971), three petroleum engineers, who argue that oil companies had fallen into such trap and thus suffered unexpected low profit rates in the 1960's and 1970's on OCS lease sales "year after year"). Thus, bidding naively based on one's information would lead to negative expected profits, so that in equilibrium, a rational bidder internalizes the winner's curse by bidding less aggressively. In other words, bidders must bid more conservatively the more bidders there are, because winning implies a greater winner's curse. The greater the level of competition, the worse the news associated with winning (Milgrom, 1989; Bulow and Klemperer, 1999; Hong and Shum, 2002; Haile et al., 2003; Hendricks K. and Porter, 2003).

Thus, in common-value auctions, an increase in the number of bidders has two counteracting effects on equilibrium bidding behaviour. First, the increased competition leads to more aggressive bidding, as each potential bidder tries to miximise her chances of winning against more rivals: this is the *competitive effect.* Second, the winner's curse becomes more severe as the number of potential bidders increases, and rational bidders will bid less aggressively in response: this is the *winner's curse effect.* [5] If the winner's curse effect is large enough, i.e. more than compensates for the increase in competition caused by more bidders, prices could actually rise - in the context of procurement auctions - as the number of competitors increases. As a result, governments should restrict entry, or favour negotiations over auctions (Bulow, J. and Klemperer, P., 1996; Hong and Shum, 2002) when the winner's curse is particularly strong.

In this chapter, we empirically assess the impact of the number of bidders on bidding behaviour in the particular case of toll road concession contract auctions (highways, roads, bridges, tunnels). In these contracts, concessionaires undertake the design, building, financing and operation of the relevant

private-value paradigm, $x_i = c_i \forall i$ (*i.e.* each bidder knows his true valuation for the object) while in the pure common-value paradigm, $x_i = c \forall i$ (*i.e.* the value of the object is the same to all bidders, but none of the bidders knows the true value of the object).

[5] Thus, what is called winner's curse effect in the rest of the paper is actually the internalization of the winner's curse.

facility and their main source of revenue are the tolls that they can charge to users for the whole length of the concession. While there have been some empirical studies on the impact of the number of bidders on prices (Bulow and Klemperer, 1999; Gomez-Lobo and Szymanski, 2001; Hong and Shum, 2002) or on the impact of public information on bidding (De Silva et al., 2005) in procurement contract auctions, there has been, to our knowledge, no such analysis on concession contract auctions whereas these auctions are special in numerous ways and should deserve a special attention.

First, the stakes involved in such auctions are large since it has been recognised that infrastructure levels and quality significantly matter for economic growth and poverty alleviation. There are many of empirical studies illustrating the impact of infrastructure on economic growth, among the more recent are Canning (1998), Calderon et al. (2003) and Calderon and Serven (2003). These studies show that a 1 percent increase in the stock of infrastructure can increase GDP by up to 0.20 percent. In response to this and given the scarcity of public funds, most countries have been turning to the private sector for financing and operation of infrastructure services. Most often, as explained above, they award these services contracts via low-bid auctions, so there appears to be important efficiency and revenue lessons to be learned from the results.

Second, they are common-value auctions. In fact, uncertainty about future traffic - forecasting errors and associated risks are characteristics of infrastructure projects, the differing access to information about future states of the world across bidders, and their differing models, lead to common values.

Third, within the set of such auctions, projects appear to differ significantly in the level of common uncertainty associated with traffic forecasts. There are two main factors that can reduce the level of contract valuation common uncertainty: the public release of information about future traffic, and the length of the facility. As the theory suggests that the effects of the winner's curse should be more apparent in auctions with a greater degree of common uncertainty (Milgrom and Weber, 1982, theorem 16), these auctions permit the estimation of the importance of information dispersion relative to traffic uncertainty in these settings.

Finally, but perhaps more interestingly, a particular characteristic of such auctions is that they are for public private contracts, which potential for renegotiation becomes to be highlighted for less developed countries (Guasch et al., 2003, 2005; Estache, 2006; Guasch, 2004; Laffont, 2005), but also for developed countries (Gomez-Ibanez and Meyer, 1993; Engel et al., 2003, 2005, 2006; Athias, 2006), and clearly contributes to the inefficiency of PPPs. Imperfect enforcement leading to renegotiations is therefore a major characteristic of these contracts, which can strongly question the theoretical effects pointed out above. In fact, these effects stand under the classical assumption that bidders are able to commit with bidding promises. One obstacle to the theoretical conclusions may be the realization by the intelligent bidder that the contract price may later be subject to profitable renegotiation. This fact affects bidding behaviour in subtle ways, and may strongly question the two theoretical effects highlighted above (Milgrom and Weber, 1982).

In order to consider the empirical importance of these considerations, we collected original data, although very difficult to obtain, on the difference between the actual traffic and the traffic forecast included in the winning bids, for 49 worldwide toll road concession contracts. Thus, we use the availability of data on ex post realizations of common traffic value to determine whether firms are cognizant of the winner's curse, assuming that traffic forecast is a good proxy for the value of bids, and hence the ratio between traffic forecast and actual traffic a good proxy for bidding behaviour.

We show that bidders bid less aggressively in toll road concession auctions when they expect more competition, i.e. the winner's curse effect is particularly strong in toll road concession contract auctions. In addition, we find, in agreement with the theory, that the winner's curse effect is stronger for shorter facilities or for projects for which the procuring public authority did not release her own traffic forecasts, *i.e.* in auctions with a greater degree of common uncertainty. Finally, we show that, in concession contracts, the public authority is exposed to the risk that the private operator behaves opportunistically during the execution phase of the contract. In fact, we observe that bidders bid more strategically when they expect a higher likelihood of renegotiation. In other words, the perspective of later profitable renegotiation does question the theoretical framework.

The policy implication of our results is not straightforward. In fact, while the traditional implication would be that more competition is not always desirable when the winner's curse effect is particularly strong, in toll road concession contract auctions, more competition may be however desirable. In fact, even if the winner's curse effect in such auctions is particularly strong, it reduces the systematic traffic overestimation due to methodological and behavioural sources. Thus, governments, whose objective function is to maximise the long-term social welfare, and then minimize strategic renegotiations, may wish to maintain the procedure as open as possible.

We believe the contribution of this study is twofold. At the empirical level, using a unique dataset - the most exhaustive one on toll road concessions auctions -, we propose a test of auction theory. This kind of test has been quite limited by the lack of suitable data on bidding behaviour, as pointed out by Laffont (1997) in a survey of the empirical auctions literature. We also highlight the importance of the public release of contract information and the bid effects of uncertainty over the value of a contract, which has been largely ignored. At the theoretical level, we show that the perspective of later profitable renegotiation does affect bidding behaviour (we observe that the effect of the winner's curse depends on the likelihood of renegotiation), and thus we stress the necessity to improve the theoretical framework by considering the transaction as a whole, *i.e.* considering the impact of not only the ex ante but also the ex post conditions on bidding behaviour.

The chapter is organized as follows. Section 2 presents the particular features of toll road concession auctions. To formalize the effects of an increase in competition on bidding behaviour in such auctions, we present in Section 3 a simple model of competitive bidding with common value components, and state our three theoretical propositions. Section 4 provides a description of the data while section 5 reports the econometric results. In Section 6, we provide a robustness analysis of our results and Section 7 discusses the policy implications of our work and offers some concluding comments.

3.2 Auctions for Toll Road Concessions

3.2.1 First-Price, Sealed-Bid Auctions

We study here the bidding behaviour in first-price, sealed bid auctions, using data on road concessions. In a first-price, sealed-bid auction, each bidder independently and privately picks a price and offers to buy the contract at that price. The one who bids the lowest price wins (most of toll road concession contracts are awarded via low-bid auctions with adjudication criteria going from the lowest toll, to the lowest public subvention required, or to the shortest length of the concession).

Concession contracts are most often awarded in two stages; in the first stage, private consortiums submit their technical qualifications, following the rules defined by the public authority. In the second stage, qualified consortiums - the consortiums selected after the first step - are allowed to bid. The concession is then awarded to the consortium with the best bid (sometimes there is an additional stage between the second stage and the selection of the best bid, which consists in selecting the two best bidders and asking them to submit in a third stage their best and final offer). Except in exceptional cases, the number of bidders qualified to bid is published by the public authority as a matter of transparency. It is therefore a known variable to the participants.

3.2.2 Common Value Auctions

Toll road concession auction environments fall in the common values category. As a matter of fact, the concession contract being bid for will not be fulfilled immediately and bidders have different information about future states of the world - e.g. market conditions or the supply and demand of substitute objects.

The degree of complexity and uncertainty comes directly to bear in the design of infrastructure concession contracts. Forecasting errors and associated risks are characteristics of infrastructure projects. Studies of such errors (as discussed in the precedent chapters) show that future traffic is usually overestimated. In fact, the uncertainty in forecasts induces the possibility of manipulation that is exacerbated by the information asymmetries in concession projects.

In addition, bidders have access in such an environment to different information. A bidder might conduct her own traffic forecast survey of a toll road concession or might learn about market conditions from her own customers and suppliers. Furthermore, even if bidders have access to the same market data, they may have different methods or rules-of-thumb for using this information to form beliefs about the contract's value. The output of one bidder's model (her signal) might then be useful to another bidder in assessing her own valuation even after seeing the output of her own model (Athey and Haile, 2007). In such cases it may be appropriate to model bidders as having different private information of a common values nature.

Thus, each bidder's traffic appraisal represents just an estimate, subject to error. No bidder knows what future traffic will be and each realizes that the other bidders may possess information or analyzes that the bidder would find useful for her own traffic forecast.

As a result, in toll road concession auctions, the winning bidder may be the one who most overestimate future traffic. This is all the more true that under first-price, sealed-bid auctions, bidders have less information on other bidders' estimates of project value.[6]

Thus, there is a greater likelihood under sealed bidding that the winner's curse will occur - that the winning bidder is the unfortunate one who, out of ignorance, overestimates the value of what is being auctioned (Milgrom and Weber, 1982; Klein, 1998). Bidders who would fail to take this selection bias into account at the bidding stage would be subject to the winner's curse. How then should reasonably sophisticated bidders behave? A frequent piece of advice is: *bid cautiously*. Milgrom (1989) for example suggests that to make money in competitive bidding, you will need to mark up your bids twice: once to correct for the underestimation of costs - traffic overestimation in our case - on the projects you win, and a second time to include a margin for profits. Besides, since it is reasonable to expect the selection bias to increase when

[6] As first demonstrated by Milgrom and Weber (1982) for symmetric common values environments, the information revealed publicly by losing bidders' exits in an ascending auction reduces both the severity of the winner's cruse and the informational rents obtained by the winner, leading to higher expected revenues than with a first-price sealed-bid auction.

competition gets fiercer, he adds that the mark-up to adjust for underestimation - traffic overestimation - will have to be larger the larger is the number of your competitors.

3.2.3 Auctions with Differing Levels of Common Uncertainty

The theory suggests that the effects of the winner's curse (the internalization of the winner's curse by bidders) should be more apparent in auctions with a greater degree of common uncertainty. To the extent that the magnitude of the winner's curse decreases as the common uncertainty concerning the value of the auction decreases, bidders will less internalize the winner's curse as the common uncertainty concerning the value of the auction decreases. In other words, the larger the relative size of the common-value component, the more cognizant of the winner's curse bidders are expected to be when competition increases (Milgrom and Weber, 1982; Goeree and Offerman, 2003).

There are two main factors that can reduce the level of contract valuation common uncertainty in the first-price, sealed bid toll road concession auctions: the public release of information about future traffic and the characteristics of the facility. The impact of the public release of information on bidding behaviour in auctions with common value uncertainty begins to be studied in the experimental or empirical literature (Kagel and Levin, 1986; De Silva et al., 2005). Such studies show that, in first-price, sealed bid auctions, public information reducing item valuation uncertainty can lead to more aggressive bidding behaviour [7] and that this effect can be more pronounced in auctions with larger common uncertainty.

While the auction format for toll road concessions is quite similar across auctions, a feature that varies across auctions is the information provided to

[7] This effect has been mitigated by Kagel and Levin (1986). They show that in presence of a winner's curse (*i.e.* bidders do not internalise the winner's curse), providing public information generates lower average winning bids and reduced seller's revenues. To the extent that the magnitude of the winner's curse decreases as the common uncertainty concerning the value of the auction decreases, public information will result in a downward revision in the most optimistic bidder's valuation of the auction. They point out the fact that the differential response to public information conditional on the presence or absence of a winner's curse has practical implications which have largely gone unrecognized in the literature.

bidders regarding the procuring authority's internal forecast of the future traffic. Some procuring authorities release this information prior to bidding and others do not, so the level of information dispersion varies across auctions in the sample. This effect is all the more important that governments negotiators juggle with multiple concerns and more general expertise than private partners with focused specialized negotiators and advised by deal specialists with insufficient sectoral and macro vision. This variation helps identify the effect of changes in information dispersion on bids.

In addition, in a study of computer auctions on ebay, Yin (2005) examines the effect of value dispersion and seller reputation on prices. She finds that the seller's reputation complements information provided in the auction descriptions by lending more credibility to that information. Thus, we can also expect that the level of common uncertainty also varies with the procuring authority's reputation when the latter chooses to release her own traffic forecast.

Another way to distinguish toll road projects regarding their common traffic uncertainty is to account for their differing uncertainty-leading characteristics, in particular the physical length[8]. In fact, based on the preceding literature on this sector and on discussions with some private concessionaires, we believe that there is less uncertainty associated with traffic forecasts of longer facilities. Although no any study (as long as we know) has focused on the relationship between the physical length and the methodological problems associated with the forecasting exercise, we can give at least three arguments supporting this hypothesis; first, the large numbers law: since the number and size of zones involved (possible Origin-Destination pairs) is much higher in long interurban facilities than in short ones, misspecification or error prediction on some OD's has less impact in equilibrium; second, if the value of travel time savings increases with the travel length, misspecification should occur for small savings because studies on stated and revealed value of travel time savings usually evaluate large time savings; third, short distance travels do not follow the traditional relationship between GDP and mobility and are determined

[8]This is also a way for us to check the robustness of the results obtained with the public release of information criterion, since the public release of information may affect the number of bidders (if bidders base their decision to submit a bid on this type of information), implying that the coefficient of the PUBLICINFO variable crossed with the number of bidders may be biased.

by life patterns. In particular, in urban transport, demand growth is strongly impacted by urban, land-use and transport policy (Schafer, 2000).

Moreover, using an external sample (22 motorway sections in France, with forecast errors ranging from 5% to 50%, none of them included in our analysis) we can corroborate this hypothesis, as we can see in figure 3.1, where the tendendy line represents a R^2 of 0.2.

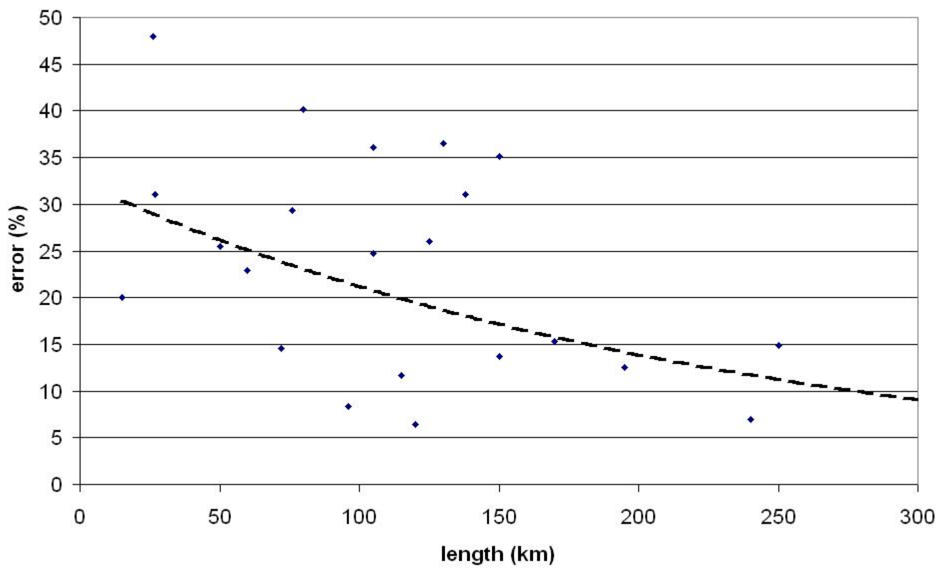

Figure 3.1: Length and Forecast Error.

3.2.4 Renegotiation in Toll Road Concessions

A particular characteristic of toll road concession auctions is that they are public-private contracts, which potential for renegotiation becomes to be highlighted for less developed countries (Guasch et al., 2003, 2005; Estache, 2006; Guasch, 2004; Laffont, 2005), but also for developed countries (Gomez-Ibanez and Meyer, 1993; Engel et al., 2003, 2005, 2006; Athias, 2006), and clearly contributes to the inefficiency of PPPs. For instance, in a study on more than 1,000 concession contracts awarded during the 1990s in Latin America, Guasch (2004) found that 53% of the concessions in the transport sector were renegotiated, and this took place on average only 3.1 years after the signing of the contract.

Some renegotiation is desirable and is to be expected as contracts are in practice necessarily incomplete. Exogenous events that are not induced by either the government or the operator (like currency devaluation) can significantly affect the financial equilibrium of firms, and can be used as an opportunity to redistribute rents. However, the high incidence of renegotiations, particularly in early stages, appears to be beyond the expected or reasonable levels, and raises concerns about the validity of the concession model in which renegotiations would not be taken into account (Guasch et al., 2003). It might induce excessive opportunistic behavior by the operators, or by the government, in detriment to the efficiency of the process and overall welfare.

Once an enterprise has been granted a concession in an infrastructure sector - and the eventual bidding competitors are gone - that enterprise may correspondingly be able to take actions that "hold up" the government, for example through insisting on renegotiating the contract ex post. The inherent contractual incompleteness, the potential incentives for political incumbents to use renegotiation to anticipate infrastructure spending and thereby increase the probability of winning an upcoming election (Engel et al., 2006), and the perceived leverage of the enterprise vis à vis the government in a bilateral negotiation constitute powerful potential factors to seek renegotiation of the contract and secure a better deal than the initial one.

Thus, when bidders expect a high likelihood of renegotiation that renders it possible to avoid any losses, they have strong incentives to submit bids containing promises difficult to satisfy, with the sole purpose of being awarded the tender (Spulber, 1990). Uncertainty in forecasts is then used in a strategic way by bidders, which is exacerbated by information asymmetries in concession projects. Moreover, traffic overestimation (up to the constraint of credibility) may represent an equilibrium in the short-term. In fact, while candidates submit opportunistic bids to increase their probability of success, the more aggressive the bids, the better it would be for the public procuring authority, since it is more efficient in the short-term. Moreover, financial agencies and lenders, suspecting that traffic forecasts are strategically increased, find a risk-sharing agreement that cushions them against any losses.

This major feature of toll road concessions can strongly question the theoretical effects highlighted above to the extent that the bidder realizes that there is no point in internalizing the winner's curse (Milgrom and Weber, 1982). Thus, depending on the likelihood of renegotiation, bidders will more or less internalize the winner's curse as the number of bidders increases.

3.3 Bidding for Toll Road Concessions: A Simple Model

We now present a simple model of competitive bidding that takes into account the various features highlighted above.

3.3.1 Model Framework

For concreteness, let assume that firms bid on lowest toll (this is not essential). We assume that there exists a one-to-one, decreasing, relation between the traffic forecast and the toll included in the bid. First, this boils down assuming that the costs (global investments and operation costs) are independently identically distributed - this assumption is made by numerous papers on PPP (e.g. Engel et al. (2007)) -, and that costs underestimation cannot be used strategically; this seems realistic to the extent that concessionaires cannot complain ex post about cost underestimation since there are very few exogenous components in the cost estimation, and the uncertainty and information asymmetry between bidders and procuring authorities regarding construction costs are low. Second, this boils down assuming that rates of return are the same across firms. Again, this does not seem to be a too restrictive assumption since it is well-known that procuring authorities expect a range of values for the financial rate of return of a particular project.

Thus, the firm decides the toll it wants to bid, and then puts pressure on the forecaster so that she approves the traffic forecast consistent with this bid. As already discussed, it is possible for firms to have some margin to adjust the traffic forecasts since the uncertainty associated with forecasts (exogenous and methodological) makes it very easy to manipulate the forecasts. Forecasts rely upon so many assumptions that it is usually possible to adjust forecasts so that they meet such demands. For instance, considering that the project will produce higher time savings or using higher economic growth than actually expected are possible ways to overestimate demand, among many others.

Nevertheless, bidders do not have an unbounded margin to adjust traffic forecasts. As a matter of fact, the margin is first bounded by credibility. Procuring authorities have an expectation, though inaccurate, of what the future traffic can be, so the bidder is not able to manipulate indefinitely traffic forecasts. Second, the margin is bounded by the other bidders' tenders. Procuring authorities are able to compare the traffic forecasts of the different bidders and hence notice if one forecast is largely different from the others. For instance, there was a case in France where one bidder was asked for a particular audition to justify her overly high traffic forecasts compared to the others.

In addition, this above central assumption implies the implicit assumption that procuring authorities have information provided by the firms on costs, rates of return, traffic forecasts, so that they can check the consistency of the bid. This assumption seems to be realistic in the sense that, first, the financial model is most often required in the bids, second, when international development banks are involved, they have the responsibility to assess the bids, and third procuring authorities have internal resources to check the consistency of the bids [9].

Finally, this strategic bidding behaviour depends also on the possibility for bidders to renegotiate the contract. As already highlighted in the previous section, there is a high incidence of renegotiation in toll road concessions, made mainly possible by the claim that actual traffic does not meet the forecasts due to a change in the exogenous factors.

3.3.2 Model Setting

Consider the actual traffic D^A. This actual traffic is determined by nature. Each firm receives an estimate of this actual traffic defined as

$$D^E = D^A \pm \varepsilon$$

[9] Discussions with experts (from France, Chile and Spain) and some independent regulatory authorities (Brazil, Portugal) also corroborate this assumption.

where ε is i.i.d. with zero mean, so that bidders believe that the average of bidders' traffic forecasts is a good estimate of the actual traffic (a standard assumption in common-value models; see for example Bikhchandani and Riley (1991), Bulow et al. (1999), Goeree and Offerman (2003)). In addition, we assume that rational bidders believe that the variance of ε is increasing in the number of bidders.

Each firm chooses then a strategic traffic forecast D^S such as

$$D^S = D^E \pm s$$

As highlighted in the Section 2, the strategic bias s depends on the number of bidders, the degree of common uncertainty, and the likelihood of renegotiation. So we have

$$s = f(NB, CU, PR)$$

where NB is the number of bidders, CU the level of common uncertainty, and PR the likelihood of renegotiation.

Given D^S, each firm chooses the toll $p = g(D^S)$ with $g' < 0$ and $g'' < 0$. As highlighted in the previous section, g is the same for each firm and given ex ante. We then have $p = g(D^E \pm f(NB, CU, PR))$.

The net present value can be written as

$$NPV = -\int_{tt}^{t0} I_t e^{-rt} dt + \int_{t0}^{tf} [p_t D_t^A(p_t) - C(D_t^A)] e^{-rt} dt \qquad (3.1)$$

where I is the initial investment and C the operation and maintenance costs.

We suppose that the demand is inelastic (with respect to both price and quality) and, as already discussed, that the main strategic variable is the demand, so that costs do not matter. Within this framework, only the gross benefit matters, which is

$$B = \int_{t0}^{tf} [p_t D_t^A] e^{-rt} dt \qquad (3.2)$$

However, at the bidding stage, the demand included in the financial model is D^E . Thus, given r and B, the only way to reduce the price (toll) included in the bid is to increase the traffic forecast. The probability of winning can be then written as

$$P_{win} = P(D_i^S \geq D_j^S \ \forall j) \tag{3.3}$$

where i and $j, j \in 1, ..., NB - 1$ index the bidders.

3.3.3 Number of Bidders and Traffic Forecast Deviation

Let consider the forecast error e be the difference between the traffic forecast included in the bid and the actual traffic. So we have $e = \varepsilon + s$. The winner's forecast error can then be written as

$$e_i \mid D_i^S > D_j^S \forall j \neq i = D_i^S - \frac{1}{N} \sum D_j^S \tag{3.4}$$

As the variance of ε is increasing in the number of bidders, then $e_i \mid D_i^b > D_j^b \forall j \neq i$ is strictly increasing in the number of bidders;

$$e_i \mid D_i^S > D_j^S \forall j \neq i = k(NB); k' > 0, k'' < 0; \tag{3.5}$$

In addition, the probability of winning the bid for the bidder i is proportional to her own forecast D_i^S and inversely proportional to other bidders' forecasts $D_j^S \forall j$. So we have

$$Pr(D_i^S > D_j^S \forall j \neq i) = h(D_i^S, D_j^S \forall j \neq i) \tag{3.6}$$

where

$$\frac{\partial h}{\partial D_i^S} > 0, \frac{\partial h}{\partial NB} < 0, \frac{\partial h^2}{\partial^2 D_i^S} < 0, \frac{\partial h^2}{\partial^2 NB} < 0$$

The expected forecast error is then

$$E(e_i) = k(NB)h(D_i^S, D_j^S \forall j \neq i) \tag{3.7}$$

Since bidders are risk-neutral, they want the expected forecast error to be constant, let say equal to e_i^* . Thus, as the number of bidders increases, the probability of winning the bid has to decrease as much as the error term increases. Nevertheless, we assume that the impact of the increase in the number of bidders is weaker on the probability of winning than on the error term, *i.e.* the increase in the error term is not compensated by the decrease in the probability of winning. That is

$$-\frac{\partial h}{\partial NB} < \frac{\partial k}{\partial NB}$$

This assumption seems realistic as we expect a high variance of traffic forecasts in our particular case due to the magnitude of traffic uncertainty. Thus, they have to decrease their traffic forecast to keep the expected forecast error constant. This is the winner's curse effect.

This leads to the following proposition:

Proposition 1: *The greater the number of bidders, the more likely bidders will be conservative to correct for traffic overestimation, i.e. the greater the effects of the winner's curse. So*

$$\frac{\partial D_i^S}{\partial NB} < 0$$

3.3.4 Number of Bidders and Level of Common Uncertainty

Let now consider the winner's curse effect relative to the degree of common uncertainty. We assume that the higher the common uncertainty, the higher the variance of bids, that is

$$\frac{\partial D_i^S}{\partial CU} > 0 \tag{3.8}$$

Thus, the winning expected forecast error is a strictly increasing, concave function of the common uncertaity (CU). We can then write this winning forecast error as

$$e_i \mid D_i^S > D_j^S \forall j \neq i = k(NB, CU) \tag{3.9}$$

where

$$\frac{\partial k}{\partial NB} > 0, \frac{\partial k}{\partial CU} > 0, \frac{\partial k^2}{\partial^2 NB} < 0, \frac{\partial k^2}{\partial^2 CU} < 0$$

The expected forecast error is then

$$E(e_i) = k(NB, CU)h(D_i^S, D_j^S \forall j \neq i) \tag{3.10}$$

Equations 3.8 and 3.10 indicate that an increase in the common uncertainty may have two counteracting effects on bids. First, since the variance increases with the common uncertainty, the winning bid is an increasing function of the common uncertainty (Equation 3.8). Second, to keep the expected error constant, bidders should review their bids (forecasts) downwards (Equation 3.10). As a result, the winning bid may increase or decrease with the common uncertainty, depending on which of these two effects prevails.

Furthermore, repeating the same exercise as in the previous section, we obtain that the higher the common uncertainty, the more bidders will internalise the winner's curse as the number of bidders increases

$$\frac{\partial}{\partial CU} \frac{\partial D_i^S}{\partial NB} > 0$$

This leads to the following proposition:

Proposition 2: *The greater the degree of common uncertainty, the more likely bidders will be conservative as competition gets fiercer, i.e. the greater the effects of the winner's curse.*

3.3.5 Number of Bidders and Renegotiation

As already highlighted, toll road concessions observe a high incidence of renegotiation. This feature can impact the behaviour of bidders. They might anticipate a future renegotiation that will lead them to increase their expected forecast error ex ante to the limit of the outcome they expect of the renegotiation. In other words, some dynamic concerns are now involved in the bidding behaviour.

Thus, we can write the expected forecast error in case of anticipation of renegotiation as following:

$$E^R(e_i) \in [E(e_i), \overline{e}_i^{PR}] \tag{3.11}$$

with

$$\overline{e}_i^{PR} = E(e_i)\frac{1}{1-PR} \tag{3.12}$$

where PR is the anticipated likelihood of renegotiation and $E^R(e_i)$ is the expected forecast error of the winning bidder i in case of anticipation of renegotiation. The expected forecast error is not constant anymore and as the probability of renegotiation increases, this expected forecast error increases, up to an upper bound, that is:

$$E^R(e_i) = k(NB, CU)h(D_i^S, D_j^S \forall j \neq i) \tag{3.13}$$

Then, as the probability of renegotiation increases, an increase of the number of bidders has a weaker impact on the correction of traffic forecast overestimation, that is

$$\frac{\partial}{\partial PR}\frac{\partial D_i^S}{\partial NB} > 0$$

This leads to the following proposition:

Proposition 3:*The lower the likelihood of contract renegotiation, the more likely bidders will be conservative as the number of bidders increases, i.e. the greater the effects of the winner's curse.*

The purpose of this analysis is to test this triple prediction. In other words, we will test first whether, overall, bidders in such auctions are cognizant of the winner's curse,*i.e.* whether their correction for the overestimation of future traffic is larger the larger is the number of bidders. Second, we will test whether bidders are more or less cognizant of the winner's curse according to the projects' differing levels of common-value components. Third, we will test the magnitude of the winner's curse effect relative to the likelihood of renegotiation.

3.4 Data on Road Concession Contract Auctions

We constructed a dataset consisting of 49 toll road concession contract auctions (highways, bridges and tunnels). They are from Australia, Brazil, Canada, Chile, France, Germany, Hungary, Israel, Jamaica, Portugal, South Africa, Thailand, and United Kingdom . The oldest auctions in the sample were awarded in 1989, whereas the latest was in 2003. Table 3.1 shows the distribution by country and by year. Most of data included in the database was provided by concessionaires and by regulators. Some others come from scientific and professional press. As far as we know,this database is the most exhaustive one on toll road concession auctions.

3.4.1 Dependent Variable: Traffic Forecast Deviation

In settings where bidders may be subject to the winner's curse, one often recommends that bidders be cautious: bidders need to correct for overestimation of future traffic and increase their correction on their estimate when competition gets fiercer. As already highlighted, a good measure for this correction is the relative discrepancy between the traffic forecast and the actual traffic.

We have data on the traffic forecasts included in the bids submitted by the **winning bidders**, and on actual traffic coming from traffic counts. The average ratio between them is called Traffic Forecast Deviation (TFD). Thus, we define our dependent variable as following:

$$TFD = \frac{1}{n} \sum_{t=t_0}^{t_0+n-1} \frac{forecast_t}{actual_t} \tag{3.14}$$

where $actual_t$ is the actual traffic observed in year t, $forecast_t$ is the traffic forecast for the year t and n is the number of years for which we could calculate this deviation. As data availability varies across projects, the variable *TFD* used in the regressions is the average deviation for the period for which we have both data on forecast and actual traffic. This period ranges up to 7 years. We take the average *TFD* because it captures the fact that bidders can manipulate either the traffic forecasts at the opening of the facility or the traffic growth forecasts, or both.

The interpretation of this variable is straightforward: when it tends to 1, it means that the traffic forecasts are very close to the actual one so that the winning bidders are less aggressive and conversely, when it increases, it means that the winning bidders submitted more aggressive bids. Thus, a positive impact on this variable implies a more aggressive bid and a negative impact on this variable implies a more conservative bidding behaviour.

Figure 3.2 gives the distribution of this TFD variable in the sample. One aspect of this contractual record draws immediate attention: the prevalence of traffic overestimation, as highlighted by the existing literature (e.g. Skamris and Flyvberg 1997, Estache 2001), since the average deviation is 1.25, i.e. an average overestimation of 25

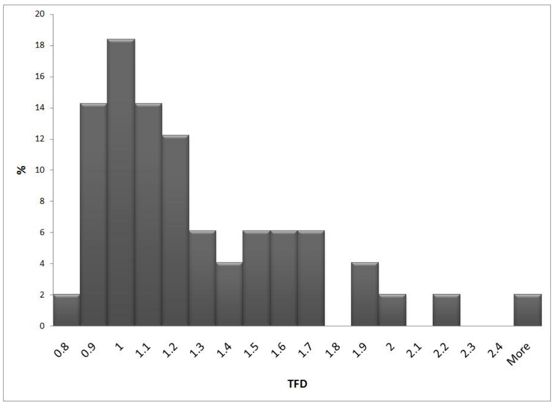

Figure 3.2: TDF.

3.4.2 Explanatory Variables

The propositions to be tested formulated above suggest three main factors that are likely to influence the bidding behaviour: the number of bidders, the degree of common uncertainty, and the likelihood of contract renegotiation.

The actual number of bidders accounts for the level of competition (it represents the number of bidders that actually bid after the prequalification stage). Figure 3.3 presents the distribution of the number of bidders in our sample. Most Auctions have between 2 and 4 bidders [10]. Table 3.2 reports that on average there were 3.9 bidders per contract, ranging from 1 to 9 bidders across contracts. The hypothesis is that bidders will be more conservative the larger is the number of bidders, *i.e.* we expect a negative impact of the *NUMBER OF BIDDERS* variable on our *TFD* variable.

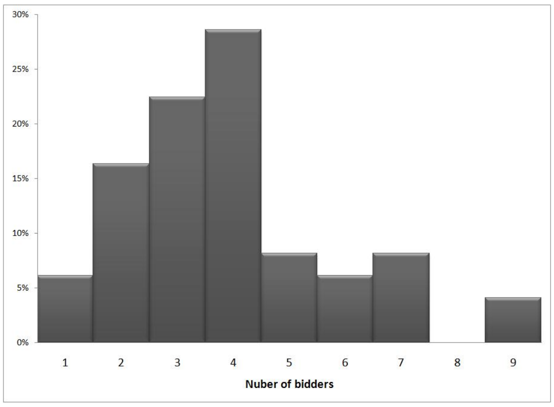

Figure 3.3: Number of Bidders.

The theoretical literature in auctions suggests that the winner's curse effect should be more pronounced in auctions where there is greater common uncertainty. As explained above, to examine the potential differences in the effect of the competition across projects, we look at the length of the facilities being auctioned. In order to capture the potential differences in the effect of the winner's curse across projects, we include in our regressions the variable *LENGTH*, reflecting the length of the facility in kilometres. Thus, the prediction is that each of these variables, interacted with the number of bidders, will have a positive impact on the traffic forecast deviation.

So as to take into account a reputation effect of the procuring authority that could complement the release of her own traffic forecast, we interacted the variable *PUBLICINFO* not only with the number of bidders but also with *GOVLEARN* variable, which reflects the experience of the procuring authority

[10] It can be noticed here that for some auctions, only one bidder submitted a tender after the prequalification stage. We take into account these auctions because the tendering was competitive.

in awarding concession contracts.

Regarding the likelihood of contractual renegotiation, Guasch et al. (2003) develop a model to accommodate renegotiations initiated by firms. This provides them with a set of predictions for the probabilities of renegotiation of concession contracts. They highlight the importance of having a regulator in place and an experimented procuring authority to limit renegotiations, the fragility of price caps, the relevance of economic shocks and political cycles, as well as the importance of good institutions (bureaucracy, rule of law, control of corruption) to reduce the incidence of renegotiations. Given the specificity of toll road concession contracts - absence of a regulator in most countries, all price-cap contracts, and consortiums composed most of time of both local and foreign companies - we introduced three variables to capture the reliability of contract enforcement. The first one, the variable *GOVLEARN*, reflects the experience of the procuring authority in awarding concession contracts. As a large number of prior concessions should decrease the probability of renegotiation Guasch et al. (2003); Guasch (2004), we expect a negative impact of this variable interacted with the number of bidders variable on our dependent *TFD* variable.

The second proxy for the likelihood of renegotiation is the indicator *HIGH INCOME COUNTRY* developed by the World Bank (2006). As highlighted by Laffont 2005, the prediction is that wealthier countries have more money to finance the functioning of the enforcement mechanism than poorer ones. In other words, the government's "tolerance for renegotiation" depends on the investment in enforcement. This is the reason why we expect stronger institutional framework in wealthier countries and hence a lower probability of contractual renegotiation in such countries. The hypothesis is therefore that greater numbers of bidders for projects taking place in wealthier countries will more likely lead to more conservative bidding behaviour at equilibrium than in poorer ones, i.e. to a negative impact of the crossed variable *HIC*NUMBER OF BIDDERS* on our *TFD* dependent variable (highlighting a greater winner's curse effect in wealthier countries).

However, as discussed above, we also observe renegotiations in developed countries, even if it is at a lower incidence. The legal system may then serve as a useful guide for the probability of enforcing the agreed upon contract. There has been increased attention from economists and legal scholars directed to the question of what legal environments best promote economic growth and stability. Some have suggested that common law regimes outperform civil code regimes throughout the world (La Porta et al., 1999). More specifically, institutional features that traditionally characterize a common law regime make it more difficult to renegotiate under such a legal regime than under a civil law system. The reason is that in civil law countries, legislation is seen as the primary source of law. By default, courts thus base their judgments on the provisions of codes and statutes, from which solutions in particular cases are to be derived. Courts thus have to reason extensively on the basis of general rules and principles of the code, often drawing analogies from statutory provisions to fill lacunae and to achieve coherence. By contrast, in the common law system, cases are the primary source of law, while statutes are only seen as incursions into the common law and thus interpreted narrowly.

According to these features of the different legal regimes, we assume that the likelihood of renegotiation is higher in civil law regimes and expect therefore a lower winner's curse effect in civil law countries, i.e. a positive impact of the variable CIVILLAW interacted with the number of bidders on our TFD dependent variable.

The variables used in our estimations are summarized in the following Table 3.2 and their respective distribution is given in Appendices B.

3.5 Econometric Results

In order to test our three theoretical predictions, we have performed log-log regressions (so as to be able to interpret the results in terms of elasticity). Ten models were estimated. We first analyse the overall impact of the number of bidders on bidding behaviour (Model 1). We then examine the effects of the winner's curse on contract auctions with differing levels of common-value components (Models 2 to 6). Finally, we identify, in Models 7 to 10, if the theoretical effects still hold when we account for the possibility for bidders to renegotiate the contract [11]. Results are reported in Tables 3 and 4.

[11] As the public release of information may affect the number of bidders, we introduced the institutional variables only in the model with the length variable as a proxy for uncertainty,

The first striking result we observe is that the number of bidders is clearly an important variable, driving the value of bidders' tenders. Model 1 shows that there is a negative impact of a fiercer competition on the traffic forecast deviation variable. This result corroborates our proposition 1, whatever the econometric model (at 1% significance level). It means that, overall, bidders are more conservative the more bidders there are, i.e. the effect of the winner's curse in toll road concession contract auctions is strong.

We also observe that this winner's curse effect is even larger for projects for which the common uncertainty is greater. In fact, the public release of information prior to bidding, regarding the procuring authority's internal forecast of the future traffic, has a positive impact on the traffic forecast deviation variable when interacted with the number of bidders. This result suggests, consistent with the theory, that one way to hinder the winner's curse effects is to reduce the information dispersion on the contract valuation by giving more contract information. This highlights the bid effects of uncertainty over the value of a contract, which has been largely ignored. Furthermore, we find that the impact of the public release of information on bidding behaviour is not stronger when accounting for procuring authority's experience, in contrast to Yin (2005).

These results then emphasize that the larger the relative size of the common-value component, the more cognizant of the winner's curse bidders are when competition increases. This result corroborates our proposition 2, whatever the econometric model.

Results of Models 7 to 10 show that the effects of the winner's curse are significantly higher when bidders expect a low likelihood of renegotiation. In particular, as predicted, Model 7 indicates that the effect of the variable *GOV-LEARN* interacted with the number of bidders is negative, though almost not significant, on the *TFD* variable. This may corroborate the result of Guasch (2004) of a negative impact of the experience of the public authority on the probability of renegotiation. Besides, the variable *CIVIL LAW* interacted with the number of bidders is positive on the traffic forecast deviation, implying that bidders anticipate a higher likelihood of renegotiation in civil law countries and therefore less internalize the winner's curse when bidding in such

as it is truly exogenous.

countries. This result, in contrast to what is often written on this topic, favours the approach which consists in relying on long concession-specific documents, trying to make the contract as complete as possible, i.e. trying to include every possible contingency to avoid leaving room for ex post renegotiations.

Finally, we obtain a similar result when we proxy for the likelihood of renegotiation by the wealth of the countries. In fact, we observe a negative impact of the *HIC* variable when competition gets fiercer on the traffic forecast deviation, meaning that bidders are more cognizant of the winner's curse in wealthier countries, i.e. in countries in which the probability of renegotiation is lower. These results are consistent with our proposition 3 and suggest that the effect of the winner's curse depends on the likelihood of renegotiation, and hence stress the necessity to improve the theoretical framework by considering the transaction as a whole, i.e. considering the impact of not only the ex ante but also the ex post conditions on bidding behaviour.

3.6 Robustness Analysis

One shortcoming of our work is that the true number of bidders may be unobserved and/or endogenously determined. Porter and Zona (1993) show that bid rigging may occur in construction contract auction settings. This can question our results. Nevertheless, as explained above, the bidders in our sample of contracts have little experience. Besides, toll road concession contracts are long-term contracts and Chong (2007) shows that collusion is hardly sustainable when contracts are long-term contracts. Thus, it seems uncertain that bid rigging and collusion may occur in such auctions. In addition, even if some bid rigging or collusion exists, it tends to mitigate the winner's curse effect. Yet, we still find statistical evidence of the winner's curse effect.

Much of the empirical work on auctions faces the problem of an endogenous number of bidders. The auction bidders who chose to bid may have been attracted by some aspect of the contract being auctioned that is not captured in the other regressors or is unobservable to the econometrician. If this aspect is correlated with traffic forecast deviation, then we need to instrument for the number of bidders. Nevertheless, employing potentially weak instruments may not yield more accurate estimates. Besides, our dependent variable is not the bid (or the price) itself but traffic forecast deviation, so that the potentiality of unobservable determinants of traffic forecast deviation is weak.

Nevertheless, in table 3.4, we introduce additional variables, not explicitly theoretically considered, that could potentially affect the traffic forecast deviation and alter the significance of our core variables. These are reputation effects, the duration of contract, the total construction costs, the political ideology of the public procuring authority and a trend variable.

So far, we assumed that the auction setting is static whereas auctions for toll road concessions are repeated. We could then expect a dynamic effect on bidding behaviour (Jofre-Bonet and Pesendorfer, 2003). More specifically, repeated interactions render reputational effects important in this toll road concession setting (Athias and Saussier, 2007). In fact, many of the concessionaires in these auctions bid on many contracts over time. The potential loss of future bidding eligibility may counteract concessionaires' incentives to submit opportunistic bids with high traffic forecasts, anticipating renegotiation. We then introduced the dummy variable *REPEATED* as a control variable, which takes the value 1 if the procuring authority and the winning bidder had contracted together at least once before.

The *DURATION* variable, defined as the number of months between the completion of the infrastructure construction and the end of the concession, captures the increasing uncertainty associated with long time horizons in forecasting future traffic growth. The hypothesis is that longer concession period increases uncertainty, leading to greater traffic growth forecast errors. The amount of investments - measured in terms of total construction costs - may affect the importance candidates will give to the production of a better traffic forecast and also the bidders' determination to win the auction.

It is possible that differences in political ideology (e.g. left or right leaning public authorities) might affect the number of bidders. In fact, private companies may show a lack of interest in bidding for contracts when the procuring authority is controlled by a particular political party (Athias and Saussier, 2007). We capture this effect in the control variable *LEFT*.

Finally, we include in the regressions a *TREND* variable so as to control for a temporal evolution of the traffic forecast practices for toll road concessions.

Model 11 of both estimation methods indicates that the results remain unaltered when controlling for dynamic considerations. In fact, while the variable *REPEATED* is weakly significant (15% significance level) and has a negative effect on the TFD - suggesting that reputational effect might play a role in such settings, *HIC*and *CIVILLAW* variables interacted with the number of bidders are still significant and of the expected sign (the impact of the legal regime is however less significant).

Models 12 indicate that results are not affected by the introduction of all the other additional variables and that none of these variables is significant. Thus, including control variables does neither diminish the coefficient of the competition variable, uncertainty variables and institutional variables, nor their sign and significance.

In addition, although our sample is non-random in the sense that we only have observations for which all information was available (especially regarding the traffic forecast), we cannot characterize a sample selection bias because our observations (and the observations we do not have) do not follow any selection rule; *i.e.* the function parameters of traffic forecast deviation are completely independent of the parameters of the function determining the probability of entrance into the sample. We could however suppose that a country fixed-effect can exist (determined by the institutional environment for example). Unfortunately, our within-country samples are not sufficiently large to estimate such possible effect.

Finally, to test the robustness of our results, it is also possible to perform some tests on the normality of the residuals. The Shapiro-Wilk test tests the null hypothesis that a sample came from a normally distributed population. In the Shapiro-Wilk test for normality, the p-value is based on the assumption that the distribution is normal. In our case, the p-value is extremely large (0.93) indicating that we cannot reject that residuals are normally distributed.

3.7 Conclusions

This chapter has studied the impact of the number of bidders on the effectiveness of the award process of toll infrastructure concession contracts. We first discuss what the economic theory says about this issue and the specificities of such auctions, leading to three propositions. We test these propositions using unique data gathered from a variety of sources. We show that the winner's curse effect is particularly strong in toll road concession contract auctions. More precisely, we show that bidders bid less aggressively in toll road concession auctions when they expect more competition. We also find, in agreement with the theory, that the winner's curse effect is even larger for projects for which the common uncertainty is greater. Thus, we highlight the bid effects of uncertainty over the value of a contract, which has been largely ignored.

Perhaps more interestingly, we show that, in concession contracts, the public authority is exposed to the risk of opportunistic behaviour on the part of the private subject during the execution phase of the contract. In fact, when we interact the number of bidders variable with the experience of the procuring authority, or with institutional variables, proxying for the likelihood of renegotiation, we observe that the effect of the winner's curse is weaker when the likelihood of renegotiation is higher (*i.e.* when the procuring authority is not experienced, the country is a low income country and the legal regime is a common law one). This means that bidders will bid more strategically in weaker institutional frameworks or in civil law countries, in which renegotiations are easier.

These results point out the necessity to improve the current theoretical framework for procurement policy and regulation by taking into account as a primary concern the impact of the perspective of later profitable renegotiation on equilibrium bidding behaviour. In other words, our results show that the classical assumption of auction models that bidders are able to commit with bidding promises is not satisfied and stress the necessity to improve the theoretical framework by considering the transaction as a whole, *i.e.* considering the impact of not only the ex ante but also the ex post conditions on bidding behaviour.

The policy implication of our results is not straightforward. In fact, while we show that asymmetric information overturns the common economic wisdom that more competition is always desirable, since we find a strong winner's curse effect in toll road concession auctions, we also show that there is a systematic traffic overestimation due to methodological and behavioural sources, so that in most cases bidders would know *ex post* very low or negative profit rates in they do not renegotiate the contractual terms. Thus, the short-term policy implication of our results would fit the standard view: governments should restrict entry, or favour negotiations over auctions, in toll road concession auctions to favour aggressive bidding. By contrast, the long-term policy implication of our results is that governments may wish to maintain the procedure as open as possible to the extent that the winner's curse effect reduces the systematic traffic overestimation and then reduces the likelihood that the procuring authority will have to renegotiate the contract, once eventual bidding competitors are gone.

In addition, we find that bidders less internalize the winner's curse when procuring authorities release publicly their own traffic forecast prior to bidding. Thus, procuring authorities interested in increasing the winner's curse effect, in order to incentive more conservative bids, should not release contract information that may reduce information dispersion in these toll road auction settings.

Table 3.1: Toll Road Concessions by Country and by Year

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total
Australia							1								1	2
Brazil						1	3		1							5
Canada					1						1					2
Chile				1		1	2	1								5
France		1							1				2			4
Germany								1			1					2
Hungary						2										2
Israel											1					1
Jamaica													1			1
Portugal						1				2	2	2	2	1		10
RS[a]										7						7
South Africa									1							1
Thailand	1															1
UK	1		1	1				1			1			1		6
Total	2	1	1	2	1	5	6	3	3	9	6	2	5	2	1	49

[a] RS means Rio Grande do Sul, the Brazlian southest state. It is presented as a different country since its concessions programme as well as its regulatory regime is completely independent.

Table 3.2: Data Definitions and Descriptive Statistics

Variable	Mean	Median	SD	Min	Max	Definition
TFD	1.25	1.10	0.45	0.80	3.40	Ratio forecast / actual traffic
NB	3.92	4.00	1.89	1.00	9.00	Number of bidders for the contract
Length	107.09	96.00	113.00	0.50	510.00	Length of the facility (km)
Civil Law	0.73	1.00	0.45	0	1	
HIC	0.53	1.00	0.50	0	1	1 if the country in question is a high income country; 0 otherwise.
FLEXBID	0.47	0	0.50	0	1	1 if the bidding procedure was flexible; 0 otherwise
Public Information	0.49	0	0.50	0	1	
Concessionaire Experience	1.92	1.00	2.89	0	13	Number of former toll road concessions of the winning bidder
Government Learning	2.53	1.00	3.05	0	10	Number of concessions the public authority had awarded before the present project
Trend	9.20	8.00	3.43	3.00	17.00	
Left	0.49	0	0.50	0	1	
Repeated Contract	0.49	0	0.87	0	4	
Duration	356.88	348.00	179.96	180.00	1164.00	Delay between the completion of the construction and the end of the concession (months)
Ivestment	445.77	259.00	430.26	10.00	1554.00	Total construction costs (M€)

Table 3.3: Econometric results

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
number of	-0.220	-0.257	-0.373	-0.261	-0.678	-0.660	-0.682	-0.711	-0.863	-0.873
bidders (NB)	(-2.87)	(-3.33)	(-3.29)	(-3.36)	(-2.41)	(-2.43)	(-2.45)	(-2.72)	(-2.94)	(-3.17)
Publicinf			-0.284							
			(-1.39)							
Publicinf*NB		0.110	0.305							
		(1.92)	(2.01)							
Publicinf*				0.039		0.041				
Govlearn*NB				(1.90)		(2.14)				
Length					-0.182	-0.170	-0.198	-0.238	-0.207	-0.257
					(-2.36)	(-2.28)	(-2.58)	(-3.23)	(-2.71)	(-3.48)
Length*NB					0.103*	0.089	0.119	0.134	0.113	0.144
					(1.68)	(1.50)	(1.93)	(2.31)	(1.88)	(2.48)
Govlearn*NB							-0.014			-0.004
							(-1.49)			(-0.36)
HIC*NB								-0.159		-0.138
								(-2.93)		(-2.16)
Civillaw*NB									0.131	0.117
									(1.82)	(1.71)
Constant	0.452	0.435	0.609	0.474	1.229	1.194	1.266	1.453	1.381	1.570
	(4.37)	(4.31)	(3.79)	(4.67)	(3.48)	(3.51)	(3.63)	(4.33)	(3.90)	(4.62)
R2	0.149	0.212	0.244	0.210	0.299	0.365	0.333	0.414	0.348	0.452
Adjusted R2	0.131	0.178	0.194	0.176	0.252	0.308	0.272	0.360	0.289	0.373
N	49	49	49	49	49	49	49	49	49	49

(t-stats in parentheses)

Table 3.4: Econometric results - extended

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
number of	-0.220	-0.257	-0.373	-0.261	-0.678	-0.660	-0.682	-0.711	-0.863	-0.873	-0.979	-1.016
bidders (NB)	(-2.87)	(-3.33)	(-3.29)	(-3.36)	(-2.41)	(-2.43)	(-2.45)	(-2.72)	(-2.94)	(-3.17)	(-3.45)	(-3 .42)
Publicinf			-0.284									
			(-1.39)									
Publicinf*NB		0.110	0.305									
		(1.92)	(2.01)									
Publicinf*				0.039		0.041						
Govlearn*NB				(1.90)		(2.14)						
Length					-0.182	-0.170	-0.198	-0.238	-0.207	-0.257	-0.289	-0.307
					(-2.36)	(-2.28)	(-2.58)	(-3.23)	(-2.71)	(-3.48)	(-3.77)	(-3.82)
Length*NB					0.103	0.089	0.119	0.134	0.113	0.144	0.161	0.168
					(1.68)	(1.50)	(1.93)	(2.31)	(1.88)	(2.48)	(2.74)	(2.72)
Govlearn*NB							-0.014			-0.004	0.006	0.005
							(-1.49)			(-0.36)	(0.51)	(0.36)
HIC*NB								-0.159		-0.138	-0.148	-0.143
								(-2.93)		(-2.16)	(-2.32)	(-1.72)
Civillaw*NB									0.131	0.117	0.104	0.116
									(1.82)	(1.71)	(1.52)	(1.48)
Repeated											-0.132	-0.138
											(-1.47)	(-1.49)
Investment												0.01
												(0.25)
Duration												-0.07
												(-0.56)
Left												-0.057
												(-0.68)
Trend												-0.11
												(-1.02)
Constant	0.452	0.435	0.609	0.474	1.229	1.194	1.266	1.453	1.381	1.570	1.767	2.457
	(4.37)	(4.31)	(3.79)	(4.67)	(3.48)	(3.51)	(3.63)	(4.33)	(3.90)	(4.62)	(4.83)	(2.99)
R2	0.149	0.212	0.244	0.210	0.299	0.365	0.333	0.414	0.348	0.452	0.476	0.499
Adjusted R2	0.131	0.178	0.194	0.176	0.252	0.308	0.272	0.360	0.289	0.373	0.386	0.351
N	49	49	49	49	49	49	49	49	49	49	49	49

(t-stats in parentheses)