THE MORE THE MERRIER?
NUMBER OF BIDDERS, INFORMATION DISPERSION, RENEGOTIATION AND WINNER'S CURSE IN TOLL ROAD CONCESSIONS

Laure Athias[1]
Ph.D. Student
ATOM, University of Paris Sorbonne
112 bd. de l'Hôpital, 75013 Paris, France
athias.laure@wanadoo.fr

Antonio Nuñez
Ph.D. Student
LET, University of Lyon
14, Avenue Berthelot, F-69363 Lyon Cedex 07, France
antonio.nunez@let.ish-lyon.cnrs.fr

ABSTRACT

In this paper, 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 for bidders to renegotiate. 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. Besides, we observe that this winner's curse effect is even larger for projects where the common uncertainty is greater. Perhaps more interestingly, 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. Besides our conclusion contrasts with standard results. While the traditional implication would be that more competition is not always desirable when the winner's curse is particularly strong, we show that, in toll road concession contract auctions, more competition may be always desirable.

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[1] Corresponding author.

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 intense *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 2005). In fact, 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 at private value auctions[2], *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 at 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 value equally the item of the auction[3]. 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 Capen, Clap and Campbell (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

[2] 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.

[3] 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 *private-va*lue paradigm, $c_i = x_i \forall i$ (*i.e.* each bidder knows his true valuation for the object) while in the pure *common-value* paradigm, $c_i = c \forall i$ (*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).

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 2001, Hong and Shum 2002, Haile, Hong and Shum 2003, Hendricks-Pinkse-Porter 2003).

In such common-value auctions, however, 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 maintain 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*.[4] 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 raise as the number of competitors increases. As a result, governments should restrict entry, or favour negotiations over auctions (Bulow J. and P. Klemperer 1996, Hong and Shum 2002) when the winner's curse is particularly strong.

In this paper, 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 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, Dunne, Kankanamge and Kosmopoulou 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 huge since it has been recognised that infrastructure levels and quality significantly matter for economic growth and poverty alleviation. The belief and the facts are that infrastructure services like electricity, water, telecommunications, roads, railroads, ports and airports are critical to the operation and efficiency of a modern economy. They enter as critical inputs in the provision of goods and services and impact significantly in the productivity, cost and competitiveness of the economy. Policy decisions regarding their provision have ramifications throughout the economy, and poor infrastructure services often limit competitiveness in other markets (Guasch-Laffont-Straub, 2003). There are plenty of empirical studies illustrating the impact

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

of infrastructure on economic growth, among the more recent are Canning (1998), Calderon, Easterly and Serven (2002), Calderon and Serven (2002). A 1 percent increase in the stock of infrastructure can increase GDP by up to 0.20 percent. Concerning the stock and quality levels of infrastructure as of 2000 in Latin American and Caribbean countries, Calderon and Serven (2002) show that while it has improved somehow since 1980, it is still deficient and has lost significant ground relative to East Asia and OECD countries. Those authors show that during the 1980-2000 period the Latin America infrastructure gap relative to East Asia grew by 40% for roads, 70% for telecommunications and nearly 90% for power generation, and that this widening gap can account for nearly 25% of the GDP output gap (GDP growth of East Asian economics was almost twice as large as that of Latin American countries over that period). Thus infrastructure matters and quite significantly. 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 that there appear 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 (Pickrell, 1990, Flyvberg, 1997, 2002, 2003, Odeck, 2004, Standard & Poor's, 2004) – drives on 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 (it has been recognized in the literature - Hensher and Greene, 2003, Hensher and Goodwin, 2004 - that there is less uncertainty associated with traffic forecasts of longer facilities). 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 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-Laffont-Straub 2003 and 2005, Estache 2004, Guasch 2004, Laffont 2005), but also for developed countries (Gomez-Ibanez and Meyer 1993, Engel 2003, 2005 and 2006, Athias-Saussier 2006), and clearly contributes to the inefficiency of PPPs. Imperfect enforcement leading to renegotiations is therefore a major characteristic particularly of LDCs but also of developed countries, 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 have collected original data, although very difficult to obtain, on the difference between the actual traffic and the traffic forecast included in the winning bid, in 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. For example, if the number of bidders increases from 2 to 4, traffic forecast deviation increases by 22%. Besides, 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 its own traffic forecasts, *i.e.* in auctions with a greater degree of common uncertainty. We also show that the reputation of the procuring authority complements the information that she provided about the value of the contract. 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, we observe that bidders will 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.

Besides, our conclusion contrasts with standard results. While the traditional implication would be that more competition is not always desirable when the winner's curse is particularly strong, we show that, in toll road concession contract auctions, more competition may be 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, for toll road concession contract auctions, benevolent governments, concerned with potential renegotiation, may wish to maintain the procedure as open as possible.

We believe the contribution of our article is twofold. At the empirical level, using a unique data set - the most exhaustive one on toll road concessions auctions - we first propose a test of auction theory, which 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. Then, we 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 by stressing 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 article is organized as follows. Section 2 presents the characteristics of bids for toll road concessions and states our three theoretical propositions about the effect of increases in competition on bidding behaviour at such auctions. Section 3 provides a description of the data while Section 4 reports the econometric results. In Section 5, we discuss the policy implications of our results and offer some concluding comments.

2. AUCTIONS FOR TOLL ROAD CONCESSIONS

2.1. First-Price, Sealed-Bid Auctions

In this paper we study bidding 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 goods 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, *i.e.* 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.

2.2. Common Value Auctions

Toll road concession auction environments fall in the common values category. 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. In fact, 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 (Trujillo et alii., 2002, Flyvbjerg *et al*, 2003; Flyvbjerg, 2005; Standard & Poor's, 2005) show that construction costs are generally underestimated and traffic overestimated, by large amounts. Nevertheless, these results have to be qualified regarding forecast errors on construction costs. In fact, although such errors have been related in the literature, especially in "white elephants", construction companies are nowadays able to forecast costs accurately, except for very new complex projects which constitute technological challenges.

The sources of traffic forecast inaccuracy can be classified in three main groups. First, there is the pure uncertainty effect. Economic, social, environmental and technological changes, as well as those in transport itself can affect the assumptions, especially in the long-term, making forecasts uncertain by their nature. Another important source of traffic forecast errors and biases stems from methodological or scientific sources, including data, models and hypothesis. Third, there are the behavioural sources which include optimism and opportunism. Optimism comes from the overconfidence that analysts and project promoters place in the project and in themselves. Opportunism refers to the strategic manipulation of traffic. In fact, uncertainty in forecasts induces the possibility of manipulation that is exacerbated by the information asymmetries in concession projects.[5]

Besides, 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 algorithms or rules-of-thumb for using this information to form beliefs about the contract's value. The output of one bidder's algorithm (*i.e.* its signal) might then be useful to another bidder in assessing her own valuation even after seeing the output of her own algorithm (Athey and Haile, 2005). In such cases it may be appropriate to model bidders as having different private information of a common values nature.

[5] Nevertheless, although at first sight unbiased estimations should be symmetrically distributed around the zero error, as claimed by many authors (Quinet, 1998, Standard and Poor's, 2002, Trujillo *et al.*, 2002), the influential characteristic of transport forecasts makes this assumption wrong. By influential characteristic, we mean that transport forecasts will only occur for projects for which it is known that there is a high demand forecast. Thus, influential forecasts occur when the forecast itself determines whether the forecast is tested. In other words, this means that forecasts are not launched when the project is supposed to have too low demand forecasts. Statistically unbiased influential forecasts should therefore appear optimistic because some forecasts remain untested. This effect is called the *Survivor's Curse* because there are forecasts only for survivor projects, *i.e.* for projects for which there are already some positive error forecasts. Thus, while the bias (expected error) across all forecasts is zero, the bias for tested forecasts is positive. Survivors tend therefore to disappoint (Ehrman and Shugan, 1995). As a consequence, the mere analysis of error's distributions does not allow to infer any conclusion about the bidders' strategy (Nunez, 2006).

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 analyses that the bidder would find useful for its 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 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 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 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 competition gets fiercer, he adds that the mark-up to adjust for underestimation – traffic overestimation in our case – will have to be larger the larger is the number of your competitors.

These considerations lead us to formalize, in the context of a toll road concession auction, 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.*

2.3. Auctions with Differing Levels of Common Uncertainty

The theory suggests that the effects of the winner's curse (*i.e.* 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).

[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.

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 length 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, Dunne, Kankanamge and Kosmopoulou 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. This holds even though public information signals will on average lie below the maximum private information signal. In fact, due to the affiliation of the signal values, for bidders whose private information signals is inferior to the maximum private information signal, the public information signal will raise the average expected value of the item. This will induce an upward revision of these bids, which in turn puts more pressure on the bidder with the highest private information signal to bid more out of strategic considerations (Kagel and Levin, 1986).

While the auction format for toll road concessions is quite similar across auctions, a feature that varies across auctions is the information provided to 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 my sample. This variation helps identify the effect of changes in information dispersion on bids.

Besides, 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 could also expect that a better procuring authority's reputation interacted with the public release of traffic forecast reduces even more the valuation common uncertainty.

Another way to distinguish toll road projects regarding their common traffic uncertainty is to account for their differing length[8]. In fact, based on the preceding literature on this

[7]This effect has been mitigated by Kagel and Levin (1986). They show that in presence of a 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.

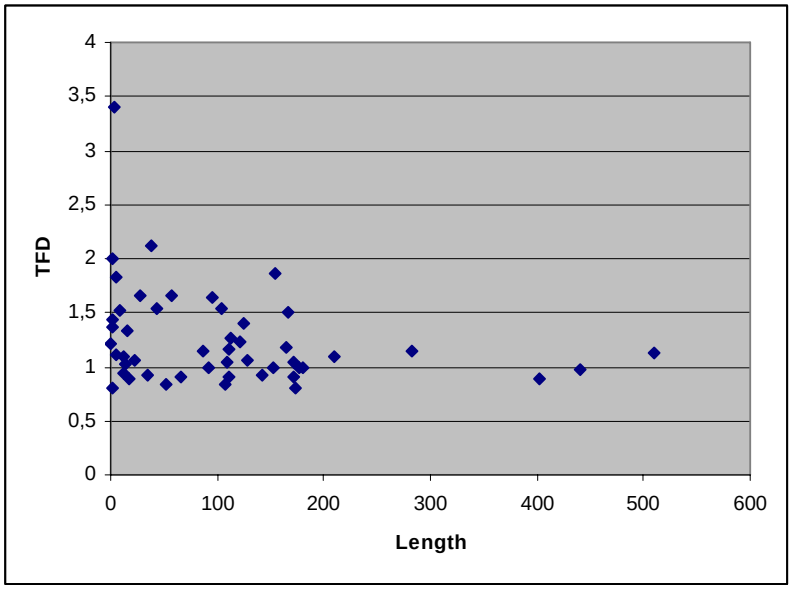
[8] This is also a way for us to check the robustness of our results since the public release of information may affect the number of bidders (if bidders base their decision to submit a bid on this type of information), implying that the coefficient of the *PUBLICINFO* variable crossed with the number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

sector (Hensher and Goodwin, 2004, Hensher and Greene, 2003) and on discussions with some private concessionaires, we believe that there is less uncertainty associated with traffic forecasts of longer facilities for the following reasons:

- large numbers law: since the number and size of zones involved (possible Origin-Destination pairs) is much higher in long facilities, misspecification or error prediction on some OD's has less impact in equilibrium;
- if the value of travel time saving increases with the travel length (as argued by many authors and empirically shown), misspecification should occur for small savings since both stated preferences and revealed preferences studies usually account for considerable savings;
- short links are usually associated with dense networks where wardrop equilibrium conditions (and existence) are hardly complex;
- short distance travels do not follow the traditional relationship between GDP and mobility.

Furthermore, as indicated by the following Figure 1, our dataset corroborates the hypothesis that longer facilities reduce the common uncertainty associated with traffic forecast since we observe less traffic forecast deviation when the length of the facility increases.

Figure 1: Facility length and traffic forecast errors



These considerations lead 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.*

The purpose of this paper is to test these predictions. 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.

However, as emphasised in the next subsection, the large rate of renegotiations in toll road concessions may impede the winner's curse effect and therefore question these two propositions.

2.4. Renegotiation in Toll Road Concessions

A particular characteristic of toll road concession auctions is that they are for public-private contracts, which potential for renegotiation becomes to be highlighted for less developed countries (Guasch-Laffont-Straub 2003 and 2005, Estache 2004, Guasch 2004, Laffont 2005), but also for developed countries (Gomez-Ibanez and Meyer 1993, Engel 2003, 2005 and 2006, Athias-Saussier 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 money 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, Laffont and Straub 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 extensive informational advantages that the enterprise possesses over the government and its perceived leverage vis à vis the government in a bilateral negotiation is a powerful potential factor to seek renegotiation of the contract and secure a better deal than the initial one.

There are two main ways to explain this high incidence of renegotiation. One way is to postulate that such contracts between a public authority and a private operator are

incomplete (Williamson 1976, Aghion et alii. 1994, Hart 1995). The reasons invoked for these contractual incompletenesses are contractual transaction costs, bounded rationality of players or information asymmetry between the contracting parties and the judicial system. Another way is to invoke arguments from the political economy (Athias-Saussier 2006) and advocate that the high incidence of renegotiation is due to corruption (Martimort and Straub 2006) or to the incentives for political incumbents to use them to anticipate infrastructure spending and thereby increase the probability of winning an upcoming election (Engel 2006).

Imperfect enforcement leading to renegotiations is therefore a major characteristic particularly of LDCs but also of developed countries which can strongly question the theoretical effects pointed out above (Milgrom and Weber, 1982). 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 and therefore that he may have no interest to internalize the winner's curse.

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 the bidders. This is exacerbated by the information asymmetries in concession projects. Moreover, traffic overestimation 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. Besides, 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 has one major consequence: depending on the likelihood of future negotiation, bidders will more or less internalize the winner's curse as the number of bidders increases. This leads to the following proposition, which has, to our knowledge, never been tested:

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.*

However, it is here assumed that the auction setting is static whereas auctions for toll road concessions are repeated, so that we could 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.

To test this triple prediction, we now turn to the empirical part of the paper.

3. DATA ON ROAD CONCESSION CONTRACT AUCTIONS

We have constructed a dataset consisting of 49 toll road concession contract auctions (highways, bridges and tunnels). Projects in the sample are fairly distributed across countries. They are from Australia, France, Brazil, Chile, Germany, United Kingdom, Jamaica, Thailand, Canada, Portugal, Hungary, Israel, and South Africa. The oldest auctions in the sample were awarded in 1989, whereas the latest in 2003. Table 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. The database that we have constructed is the most exhaustive one on toll road concession auctions.

Table 1: Toll Road Concessions by Country and by Year

	Year_c															
Country	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										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**

3.1. Dependent Variable: Traffic Forecast Deviation

As explained above, 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. A good measure for this correction is the relative discrepancy between the forecast traffic and the actual traffic. In fact, in their tenders for toll road concession contracts, concessionaires

can play on three main parameters: traffic forecasts, construction and operation costs forecasts, and the possible rent (Internal Rate of Return). We assume that bidders do not adjust their bids through their construction costs forecasts but only through their traffic forecasts. This assumption, even if critical, may be sustainable in the sense that, as explained above, there is often less uncertainty and less information asymmetry between bidders and procuring authorities regarding construction costs than traffic forecasts.

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:

$$TFD = \frac{1}{n} \sum_{t=t_0}^{t_0+n-1} \frac{forecast_t}{actual_t} \qquad (1)$$

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 play either on traffic forecasts at the opening of the facility or on 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 (a) in Appendix 1 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%.

3.2. 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 b) of Appendix 1 presents the distribution of the number of bidders in our sample. Most Auctions have

between 2 and 4 bidders[9]. Table 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.

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 existence of a public release of future traffic forecast and 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 dummy variable *PUBLICINFO* and 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 its 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 in awarding concession contracts.

Regarding the likelihood of contractual renegotiation, Guasch, Laffont and Straub (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, 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, Laffont and Straub, 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

[9] 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.

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 1997, 1998, 1999, 2004). More specifically, institutional features that traditionally characterize a common law regime make it stronger 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.

Besides, as highlighted by Bajari et ali. (2003), negotiation between bidders and the procuring authority during the bidding process makes the contract more complete, *i.e.* more suitable to contingencies. One prediction is therefore that the likelihood of renegotiation will be lower when the bidding process is more flexible. If the auctions for toll road concessions are all first-price, sealed bid auctions, there might be nonetheless some heterogeneity regarding the bidding procedure. In fact, this competitive procedure can display a differing level of negotiation or dialog during the bidding procedure between bidders and the procuring authority. While, in some competitive bidding processes, private operators will discuss with the procuring authority the contractual terms and will be able to modify the contractual terms so as to adapt at best the contract to the objectives, in others they are not allowed. The discrimination between auction and negotiation is therefore not any more relevant in the context of toll road concession auctions since some negotiation over the contractual terms may be introduced even during an auction procedure. Based on discussions with experts and in coherence with the institutional features of a common law

regime exposed above, we believe that common law regimes permit a large more flexible bidding procedure than civil law regimes.

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.

Finally, as already highlighted, repeated interactions render reputational effects important in this toll road concession setting (Athias and Saussier, 2006). 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 variables used in our estimations are summarized in the following Table 2 and their respective distribution, as well as the correlation matrix, are respectively given in Appendix 2.

Table 2: Data Definitions and Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Definition
TFD	49	1,253	0,453	0,8	3,399	Ratio forecast traffic / actual traffic
NUMBER OF BIDDERS (NB)	49	3,918	1,891	1	9	Number of bidders for the contract, after the prequalification stage
PUBLICINFO	49	0,490	0,505	0	1	1 if the procuring authority released its own traffic forecast prior to bidding; 0 otherwise
LENGTH	49	107,089	112,997	0,5	510	Length of the facility in kilometres
CIVIL LAW	49	0,735	0,446	0	1	1 if the country in question is under civil law regime; 0 otherwise
HIGH INCOME COUNTRY (HIC)	49	0,531	0,504	0	1	1 if the country in question is a high income country; 0 otherwise (*Source*: World Bank)
GOVERNMENT LEARNING	49	2,531	3,056	0	10	Number of concessions the public authority has awarded before the present project
REPEATED CONTRACT	49	0,327	0,474	0	1	1 if the procuring authority and the winning bidder have contracted at least once before; 0 otherwise

4. 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) using OLS models. Nine 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, 8 and 9, if the theoretical effects still hold when we account for the possibility for bidders to renegotiate the contract.[10] Results are reported in Table 3.

[10] 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, as it is truly exogenous.

Table 3: OLS Estimation Results

	LOG / LOG								
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
NB Bidders[a]	-0,220*** (-2,87)	-0,257*** (-3,33)	-0,261*** (-3,36)	-0,678** (-2,41)	-0,780*** (-2,88)	-0,660** (-2,43)	-0,682** (-2,45)	-0,873*** (-3,17)	-0,979*** (-3,45)
Publicinf*NB Bidders[a]		0,110* (1,92)			0,127** (2,43)				
Publicinf*Govlearn*NB Bidders[a]			0,039* (1,90)			0,041** (2,14)			
Length[a]				-O,182** (-2,36)	-0,201*** (-2,73)	-0,170** (-2,28)	-0,198** (-2,58)	-0,257*** (-3,48)	-0,289*** (-3,77)
Length[a]*NB Bidders[a]				0,103* (1,68)	0,117* (1,98)	0,089+ (1,50)	0,119* (1,93)	0,144** (2,48)	0,161*** (2,74)
Govlearn *NB Bidders[a]							-0,014+ (-1,49)	-0,004 (-0,36)	0,006 (0,51)
HIC* NB Bidders[a]								-0,138** (-2,16)	-0,148** (-2,32)
Civillaw* NB Bidders[a]								0,118* (1,71)	0,104+ (1,52)
Repeated									-0,132+ (-1,47)
Constant	0,452*** (4,37)	0,435*** (4,31)	0,474*** (4,67)	1,229*** (3,48)	1,291*** (3,84)	1,194*** (3,51)	1,266*** (3,63)	1,570*** (4,62)	1,767*** (4,83)
R^2	0,149	0,212	0,210	0,299	0,382	0,365	0,333	0,452	0,476
Adj R^2	0,131	0,178	0,176	0,252	0,326	0,308	0,272	0,373	0,386
N	49	49	49	49	49	49	49	49	49

*Significance levels: +0,15 * 0,10 ** 0,05 *** 0,01*
t-stat are in parentheses ;
a denotes the variables taken as logarithms in the log-log model.

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. In particular, the elasticity of traffic deviation with respect to the number of bidders is about -0.22. In other words, if the number of bidders increases from 2 to 4, the traffic forecast deviation variable decreases by 22%. This result corroborates our proposition 1, whatever the econometric model (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. This result is consistent with the results of Hong and Shum (2002) who find that the effect of the winner's curse on equilibrium bidding is particularly strong in highway work auctions (the low bid is 11% above the estimate when there is one bidder, and the low bid falls to 14% below the estimate when there are nine or more bidders).

Besides, we observe that this winner's curse effect is even larger for projects where 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 significant and 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 and highlights the bid effects of uncertainty over the value of a contract, which has been largely ignored.[11] 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).

In the same way, we observe that, while the direct impact on the *TFD* variable of the length variable is negative – which is consistent with the fact that less uncertain projects lead to less traffic deviation, the length variable interacted with the number of bidders has a positive and significant impact on the traffic forecast deviation (even if the direct impact of the number of bidders variable is negative). This means that, compared to projects for which the facility is shorter, *i.e.* compared to more uncertain projects, bidders on lengthier projects are less cognizant of the winner's curse.

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.

[11] We also observe that the direct impact of the release of the procuring authority's own traffic forecast on the *TFD* variable is positive (the coefficient is 0.098) but not significant. We did not introduce the direct effect of *PUBLICINFO* in our regressions because it is highly correlated with the crossed variable *PUBLICINFO*NB BIDDERS*. For this same reason, we did not introduce the direct effects of the crossed dummy variables *HIC*, *CIVILLAW* and *GOVLEARN*.

Results of Models 6, 7, 8 and 9 show that the effects of the winner's curse are significantly higher when bidders expect a low likelihood of renegotiation. In particular, as predicted, the effect of the variable *GOVLEARN* interacted with the number of bidders is significant and negative when do not account for the other institutional variables. 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 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 remain unaltered when controlling for dynamic considerations. In fact, Model 9 indicates that while the variable *REPEATED* is significant and has a negative effect on the TFD – suggesting that reputational effect is important 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 and the coefficient weaker). These results are consistent with our proposition 3 and suggest that effect of the winner's curse depends on the likelihood of renegotiation, and thus 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.

5. ROBUSTNESS ANALYSIS

One shortcoming of our work is that the true number of bidders may be unobserved and/or endogenously determined. Porter and Zona (2003) 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.

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 the following Table 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 the duration of contract, the total construction costs, the political ideology of the public procuring authority and a trend variable.

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 but 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 an unfounded 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 10 indicates that results are not affected by the introduction of such variables and that none of these variables is significant. Thus, including control variables does neither diminish the coefficient on bidders, uncertainty variables and institutional variables, nor their sign and significance.

Table 4: OLS Estimation Results with Control Variables

	LOG/LOG									
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**	**Model 10**
NB Bidders[a]	-0,220*** (-2,87)	-0,257*** (-3,33)	-0,261*** (-3,36)	-0,678** (-2,41)	-0,780*** (-2,88)	-0,660** (-2,43)	-0,682** (-2,45)	-0,873*** (-3,17)	-0,979*** (-3,45)	-1,016*** (-3 ,42)
Publicinf*NB Bidders[a]		0,110* (1,92)			0,127** (2,43)					
Publicinf*Govlearn*NB Bidders[a]			0,039* (1,90)			0,041** (2,14)				
Length[a]				-O,182** (-2,36)	-0,201*** (-2,73)	-0,170** (-2,28)	-0,198** (-2,58)	-0,257*** (-3,48)	-0,289*** (-3,77)	-0,307*** (-3,82)
Length[a]*NB Bidders[a]				0,103* (1,68)	0,117* (1,98)	0,089+ (1,50)	0,119* (1,93)	0,144** (2,48)	0,161*** (2,74)	0,168** (2,72)
Govlearn *NB Bidders[a]							-0,014+ (-1,49)	-0,004 (-0,36)	0,006 (0,51)	0,005 (0,36)
HIC* NB Bidders[a]								-0,138** (-2,16)	-0,148** (-2,32)	-0,143* (-1,72)
Civillaw* NB Bidders[a]								0,118* (1,71)	0,104+ (1,52)	0 ,116+ (1,48)
Repeated									-0,132+ (-1,47)	-0,138+ (-1,49)
Investment[a]										0,010 (0,25)
Duration[a]										-0,070 (-0,56)
LEFT										-0,057 (-0,68)
Trend[a]										-0,110 (-1,02)
Constant	0,452*** (4,37)	0,435*** (4,31)	0,474*** (4,67)	1,229*** (3,48)	1,291*** (3,84)	1,194*** (3,51)	1,266*** (3,63)	1,570*** (4,62)	1,767*** (4,83)	2,457*** (2,99)
R^2	0,149	0,212	0,210	0,299	0,382	0,365	0,333	0,452	0,476	0,499
Adj R^2	0,131	0,178	0,176	0,252	0,326	0,308	0,272	0,373	0,386	0,351
N	49	49	49	49	49	49	49	49	49	49

6. CONCLUSION

This paper has studied the impact of the number of bidders on the effectiveness of the award process of toll infrastructure concession contracts. We first come back on what the economic theory says about this issue and on 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 striking policy implication of our results contrasts with the standard view. While the traditional implication would be that more competition is not always desirable when the winner's curse is particularly strong, we show that, in toll road concession contract auctions, more competition may be desirable. In fact, even if the *winner's curse effect* is in such auctions particularly strong, it reduces the systematic traffic overestimation due to methodological and behavioural sources. Thus, for toll road concession contract auctions, governments may wish to maintain the procedure as open as possible, as it is the trend nowadays, if they are concerned with the long-term.

Another important policy implication of our results concerns the important role of the public release of contract information that may reduce information dispersion in these toll

road auction settings. In fact, we find that bidders less internalize the winner's curse when common uncertainty over contract valuation is reduced. Another way to make the bids less dependent on uncertainty is also to resort to LPVR auctions, as emphasized by Engel et al. (1997, 2002,2003).

Finally, our work favours the approach which consists in relying on long concession-specific documents, *i.e.* trying to include every possible contingency to avoid leaving room for ex post renegotiations, as well as the approach which consists in allowing negotiations over the contractual terms during the bidding procedure, trying to make the contract as complete as possible (Bajari et al., 2003).

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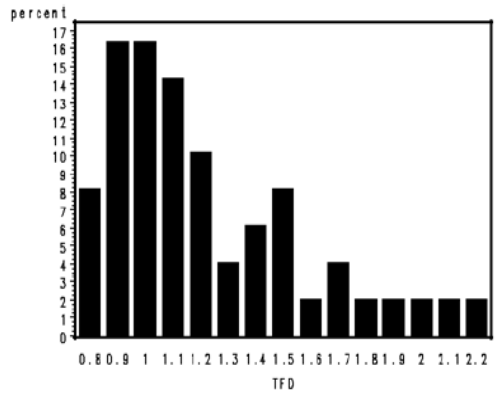
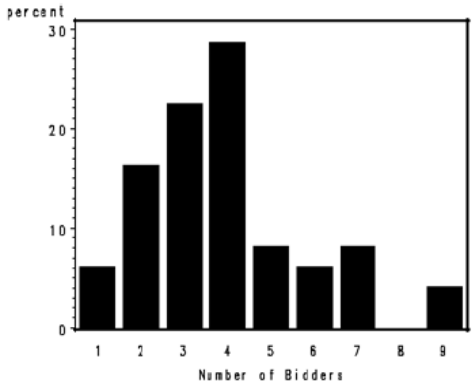
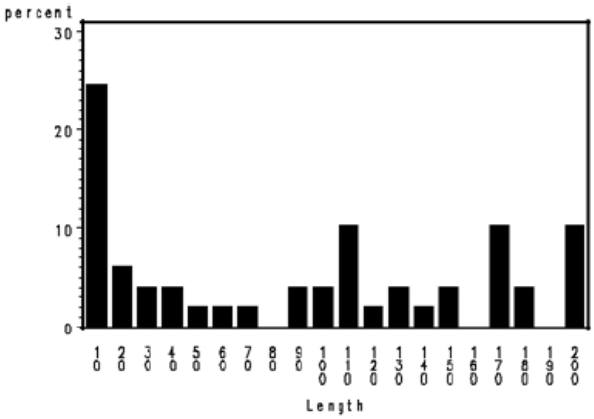
Appendix 1: Histograms for the regression variables



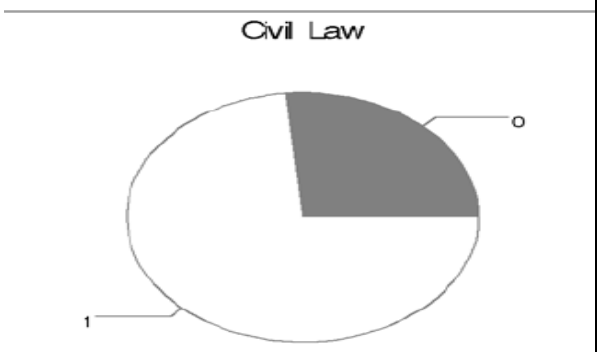
(a) Traffic Forecast Deviation



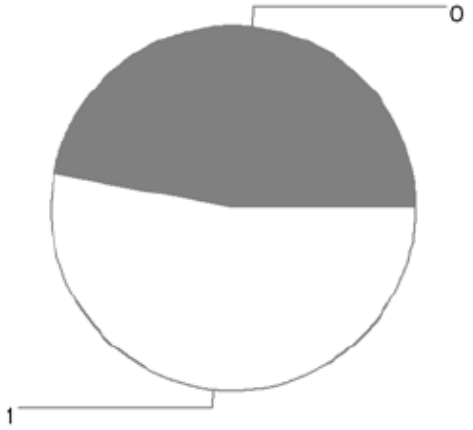
(b) number of bidders



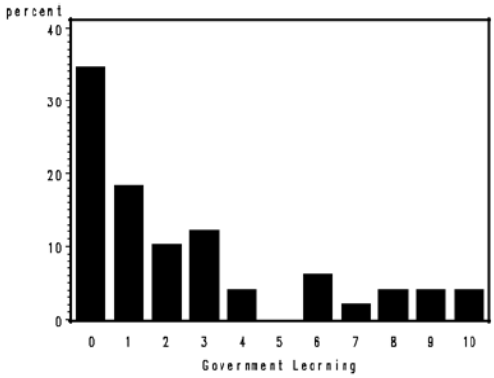
(c) length (km)



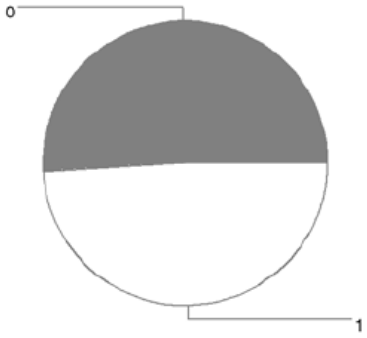
(d) Civil Law Countries



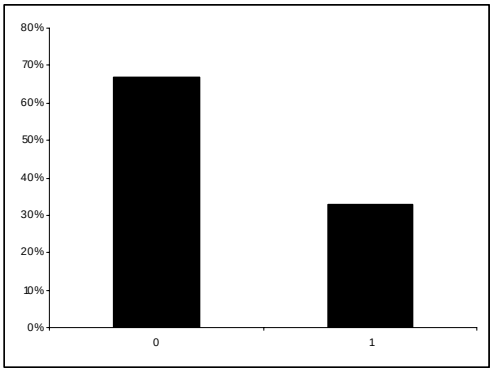
(e) HIC



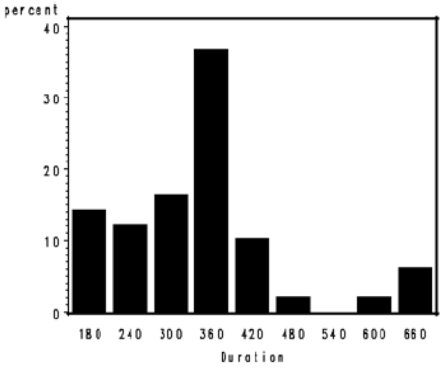
(f) government learning



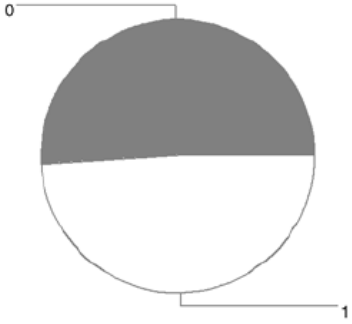
(g) Plubic Release of Traffic Forecast



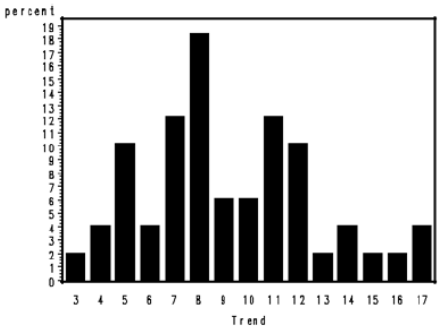
(h) repeated contract



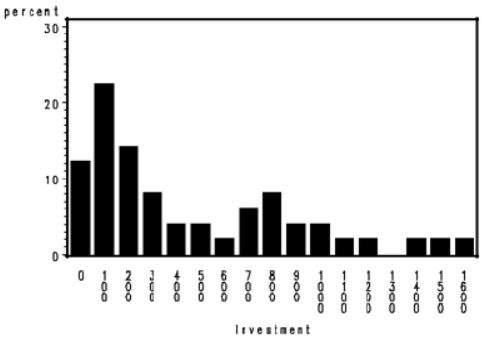
(i) Contract Duration (months)



(j) LEFT



(k) Trend Variable



(l) Investment (construction costs in million of euro)

Appendix 2: Correlation Matrix

	LOG NB BIDDERS	LOG LENGTH	LOG LENGTH* LOG NB BIDDERS	PUBLICINFO* LOG NB BIDDERS	GOVLEARN* LOG NB BIDDERS	HIC* LOG NB BIDDERS	CIVILLAW* LOG NB BIDDERS	REPEATED	LOG INVEST	LOG DURATION	LEFT
LOG NB BIDDERS	1.0000										
LOG LENGTH	-0.0063	1.0000									
LOG LENGTH* LOG NB BIDDERS	0.7425	0.6361	1.0000								
PUBLICINFO* LOG NB BIDDERS	0,2462	0,0429	0,1936	1.0000							
GOVLEARN* LOG NB BIDDERS	0.5364	0.0860	0.4844	-0,2557	1.0000						
HIC* LOG NB BIDDERS	0.4522	-0.2655	0.1976	-0,5132	0.6038	1.0000					
CIVILLAW* LOG NB BIDDERS	0.7215	0.2023	0.6565	0,2330	0.4486	0.2104	1.0000				
REPEATED	0.0221	-0.2264	-0.0749	-0,2556	0.5039	0.3174	-0.0712	1.0000			
LOG INVEST	0.1368	0.1463	0.2455	-0,3422	0.2401	0.5110	-0.0101	0.2145	1.0000		
LOG DURATION	0.1422	-0.2657	-0.0320	-0,3144	0.2862	0.5204	-0.1497	0.3007	0.5181	1.0000	
LEFT	0.2357	-0.0399	0.1661	-0.3254	0.4524	0.4015	0.2875	0.2754	0.0951	0.2802	1.0000