Number of Bidders and the Winner’s Curse in Toll Road Concessions: An Empirical Analysis

Laure Athias
ATOM, Université de Paris Sorbonne

Antonio Nuñez
Laboratoire d’Economie des Transports, Université de Lyon
NUMBER OF BIDDERS AND THE WINNER’S CURSE IN TOLL ROAD CONCESSIONS: AN EMPIRICAL ANALYSIS

Laure Athias
ATOM, Université de Paris Sorbonne
112 bd. de l'Hôpital, 75013 Paris, France
athias.laure@wanadoo.fr

Antonio Nuñez
Laboratoire d'Economie des Transports, Université de 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 road concession contracts. Such auctions are private- and common-value auctions, and they are on concession contracts which are incomplete contracts prone to pervasive renegotiations (Guasch 2004, Engel 2005, Athias-Saussier 2006). 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 dataset of 37 road concessions worldwide, we show that the winner’s curse effect is particularly strong in toll road concession contract auctions, implying the prevalence of common value components over private value components in such 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.

JEL Codes: D44, D82, H11, H54, H57, L9, L51.
Keywords: Theory of contract auctions, common value, winner’s curse, concession, opportunistic behaviour, incomplete contract.
1. INTRODUCTION

Competition for the field, or franchise bidding, has become increasingly popular to expand private participation in the infrastructure sectors. 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 \textit{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 \textit{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 tender mechanisms, e.g. the 1989 European directive on the obligation of competitive tendering or the 1993 “Sapin Act” in France.

Nevertheless, recent studies have been reporting weaknesses and limitation of such auctions, based on the experience in Latin American but also in developed countries. For example, Guasch (2004), in a study on more than 1,000 concession contracts, shows that concessions awarded through direct adjudication are far less renegotiated than concessions awarded \textit{via} competitive tendering (8% against 46%). Besides, numerous studies have highlighted the prevalence of “aggressive bidding”, which means that, from the start, concession operations are not financially viable (Gomez-Ibanez and Meyer 1993, Estache 2004, Guasch 2004). In fact, operators may consider aggressive bidding as a rational strategy if governments are unable to commit to a policy of no renegotiation. Operators are then likely to submit unsustainable bids with the intention of renegotiating better terms after the concession has been awarded.

This mixed context can be explained by a theoretical mess. In fact, on the one hand, the main economic literature emphasizes that the efficiency of the awarding procedure depends on the number of bidders. 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. An important result of the theory of contract auctions within the context of transactions between the public authority and private firms also points out that social welfare is an increasing function of the number of the participants in the competitive bidding phase. For this reason, it is in the public interest to maintain the procedure as open as possible (Bulow \textit{et al.}, 1996).

But on the other hand, while this may be true at private value auctions\textsuperscript{1}, \textit{i.e.} for auctions in which a bidder’s estimate is affected only by his own perceptions and not by the

\textsuperscript{1}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
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. 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 (Kagel and Levin, 2002). 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 2001, Hong and Shum 2002, Hendricks-Pinkse-Porter 2003).

Thus, in such 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 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. 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 as the number of competitor 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.

Nevertheless, these conclusions stand under the classical assumption that bidders are able to commit with bidding promises. One obstacle to these conclusions may be the complexity of some of the environments in which auctions are conducted. For example, as highlighted above, in bidding for concessions, the intelligent bidder realizes that the contract price may later be subject to profitable renegotiation². This fact affects bidding behaviour in subtle ways, and may strongly question the two theoretical effects highlighted above (Milgrom and Weber, 1982).

In another way, Klein (1998) quotes two enlightening and apparently conflicting sayings about competition’s merits: “whoever is about to make eternal vows, should test whether he cannot find a better partner”; according to this principle, it is in the public interest to maintain the procedure as open as possible. On the other hand “it is not the number of suitors and the size of the dowry that truly matters for a successful marriage”; this second principle challenges the usual confidence in the classical bidding process.

² Renegotiation in concessions is most often seen as a political decision than a way to avoid maladaptation costs (Guasch, 2004, Athias and Saussier, 2006).
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, 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 toll infrastructure 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 the provision of a high quality transport system is a necessary precondition for national development. Governments, having limited financial resources, rely more and more on the private provision of such 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 private- and common-value auctions. In fact, uncertainty about costs and future traffic – forecasting errors and associated risks are characteristics of infrastructure projects (Pickrell, 1990, Flyvberg, 1997, 2002, 2003, Odeck, 2004, Standard & Poor’s, 2004) – could drive on common values but differences in input efficiency across firms as well as strategic variables such as stakeholders’ preferences could drive private values. Third and finally, the likelihood of opportunism in concession contracts is not any more to be proved (Gomez-Ibanez and Meyer, 1993, Engel, 2003, Bajari et al., 2004, Estache, 2004, Guasch, 2004, Athias and Saussier, 2006). Problems of commitment and enforcement are thus a particular feature of such contracts, so that bids do not reflect binding promises.

In order to consider the empirical importance of these considerations, we have collected original data, although very difficult to obtain, on traffic deviation of the winning bids – the difference between the actual traffic and the traffic forecast included in the winning bid – in 37 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. 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, in average, if the number of bidders increases by 50%, the mark-up increases by 13%.

The theory suggests that the winner’s curse effect should be more apparent in auctions with a greater degree of common uncertainty. Within the set of auctions used in this analysis, we isolate two types of projects that appear to differ significantly in the level of common cost uncertainty associated with the specific construction tasks. The two project
types are “highway” concessions and “bridge/tunnel” concessions. As highlighted in Hong and Shum (2002) and De Silva et al. (2005), we argue that in highway concessions projects one has to rely more on the individual contractor’s state of equipment and internal efficiency to determine the cost, while in bridge and tunnel concessions there is more uncertainty that is common to all bidders. We find, in agreement with the theory, that the winner’s curse effect is stronger for bridges and tunnels concessions.

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 in weaker institutional frameworks, in which renegotiations are easier. 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, governments may wish to maintain the procedure as open as possible.

We believe the contribution of our article is twofold. At the empirical level, by focusing on toll road concession contracts, never addressed before, with a unique data set, the most exhaustive one on toll road concessions auctions. To our knowledge, this is the first paper that studies and compares the impact of the number of bidders among auctions with different degrees of common uncertainty and with different likelihood of renegotiation. At the theoretical level, first, by showing that the perspective of later profitable renegotiation affects bidding behaviour (we observe that the effect of the winner’s curse depends on the likelihood of renegotiation), and second by showing that, in some cases, even if the winner’s curse effect more than compensates for the increase in competition caused by more bidders, governments may wish to maintain the procedure as open as possible.

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 the winner’s curse in such auctions. Section 3 provides a description of the data while Section 4 reports the econometric results. In Section 5, we offer some concluding comments.

2. AUCTIONS FOR 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. Uncertainty in Toll Road Concessions

The degree of complexity and uncertainty comes directly to bear in the design of infrastructure concession contracts. By its nature, infrastructure concession, as long-term contracts, involves a high degree of uncertainty. Some might therefore say that there is nothing new here and that most business decisions are taken in the face of uncertainty. But it is a matter of degree, and uncertainty in infrastructure decision is generally much greater than in most ordinary business decisions. As a matter of fact, forecasting errors and associated risks are characteristics of infrastructure projects. Studies of such errors (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 (such as most often bridges, tunnels).

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

---

3 We discuss below the differences in the uncertainty of costs associated with highways and bridges/tunnels concessions. This differing level of cost uncertainty permits us to compare the impact of the number of bidders on bidding behaviour among auctions with different degrees of common uncertainty.
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.

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., 2004), 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 we know 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 inferring 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.

Nevertheless, there are not only common-value components in bidders’ valuations but also private-value components. In fact, as explained above, differences in input efficiency across contractors as well as strategic variables such as stakeholders’ preferences could drive private values. Thus, a part of the bidder’s valuation of the auctioned project depends only on its private information. Toll road concession contract auctions have therefore both private- and common-value components.

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 sealed bids, bidders have less information on other bidders’ estimates of project value. Thus there is greater

---

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 private-value 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).
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 will have to be larger the larger is the number of your competitors.

These considerations lead us to formalize the following proposition:

**Proposition 1:** The greater the number of bidders, the more likely bidders will increase their mark-up to correct for cost underestimation and traffic overestimation, i.e. the greater the effects of the winner’s curse.

Besides, the theory suggests that the effects of the number of bidders should be more apparent in auctions with a greater degree of common uncertainty. In particular, 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.

These considerations lead to the following proposition:

**Proposition 2:** The greater the degree of common uncertainty, the more likely bidders will increase their mark-up 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 the case of auctions for toll road concessions. In other words, we will test first whether, overall, bidders in such auctions are cognizant of the winner’s curse, i.e. whether their mark-up to correct for the underestimation of construction costs and 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.

**2.3. The Inability to Make Commitments**

The likelihood of opportunism in concession contracts is not any more to be proved. The related literature to concession contracts, empirical (Gomez-Ibanez and Meyer 1993, Engel
et al., 2003, Bajari et al., 2004, Estache 2004, Guasch 2004) as well as theoretical (Williamson, 1976), points out that these contracts between a public authority and a private entity are particularly pervasive renegotiations prone. In a study on more than 1,000 concession contracts awarded during the 1990s in Latin America, Guasch (2004) found that, within three years, terms had been changed substantially in over 60% of the contracts. According to him, the frequency of renegotiation is troubling because the contractual changes often are not desirable. In some cases, renegotiations allow governments to expropriate concessionaires after they have sunk their investments. In other cases, concessionaires renegotiate contracts in order to shift losses to taxpayers.

Thus, in weak institutional environments, bidders have strong incentives to decrease their mark-up so as to make sure that they will win the auction, anticipating by the way future negotiations that render it possible to avoid any losses. Moreover, cost underestimation and traffic overestimation may represent an equilibrium. In fact, while candidates decrease their mark-up to increase their probability of success, for the public authority, the weaker the mark-up the best the bid would be, which is economically more efficient in the short-term. Thus, procuring authorities may not have incentives to take into account the reputational capital (in terms of pervasive renegotiations) of the bidders or to commit to a policy of no renegotiation so as to counteract bidders’ incentives to submit strategic bids if they are only interested in the short-term, which is presumable. Besides, financial agencies and lenders, suspecting that the mark-up is strategically decreased, find a risk-sharing agreement that cushions them against any losses.

This feature of toll road concessions has one major consequence: depending on the likelihood of future negotiation, bidders will more likely increase, or not, their mark-up to correct for cost underestimation and traffic overestimation as the number of bidders increases. In particular, we should expect that the effects of the winner’s curse will be more apparent in strong institutional environments than in weak institutional frameworks. This leads to the following proposition:

**Proposition 3:** The lower the likelihood of contract renegotiation, the more likely bidders will increase their mark-up as the number of bidders increases, i.e. the greater the effects of the winner’s curse.

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 37 toll road concession contract auctions (highways, bridges and tunnels). Projects in the sample are from France, Brazil, Chile, Germany, United Kingdom, Thailand, Canada, Portugal, Hungary, Israel, and South Africa.
The oldest auctions in the sample were awarded in 1988, whereas the latest in 2003. Most of data included in the database was provided by concessionaires and by regulators. Some others come from scientific and professional press.

3.1. Dependent Variable: Mark-Up over Traffic Estimate

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 the underestimation of costs and overestimation of future traffic and increase their mark-up on their estimate when competition gets fiercer. A good measure for this mark-up is the relative discrepancy between the actual traffic and the forecast traffic. In fact, in their tenders for toll road concession contracts, concessionaires can play on three main parameters: traffic forecasts, construction costs forecasts and margin on construction costs. We assume that bidders do not adjust their bids through their construction costs forecasts and their margin on construction costs but only through their traffic forecasts. This assumption, even if critical, may be sustainable in the sense that there is often less uncertainty on construction costs and less information asymmetry between bidders and procuring authorities regarding construction costs than traffic forecasts. Besides, if the builder and the operator are integrated in the same firm (which happen quite often), they can only play on traffic forecasts so that the winner’s curse effect due to common cost uncertainty will impact on traffic forecasts.

We have data on traffic forecasts, coming from traffic used in the bid, and on actual traffic, coming from traffic counts. Thus, we define our dependent variable as following:

\[
Mark-up = \frac{1}{n} \sum_{t=n_0}^{t+n-1} \frac{\text{actual}_t}{\text{forecast}_t}
\]

where \(\text{actual}_t\) is the actual traffic observed in year \(t\), \(\text{forecast}_t\) is the traffic forecast for the year \(t\) and \(n\) is the number of years for which we could calculate this deviation. The interpretation of this variable is straightforward: when it tends to 1, it means that the mark-up increases and conversely, when it tends to 0, the mark-up decreases. Thus, a positive impact on this variable implies an increase of the mark-up and a negative impact on this variable implies that the mark-up decreases. As data availability varies across projects, the variable \(MARK-UP\) used in the regressions is the average mark-up 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 mark-up 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.
Figure (a) in Appendix 1 gives the distribution of this MARK-UP variable in the sample. One aspect of this contractual record draws immediate attention: the prevalence of traffic overestimation, as highlighted by the existing literature, since the average mark-up is 0.815, i.e. an average overestimation of 19%, and traffic is overestimated in 81% of the projects.

3.2. Explanatory Variables

The propositions to be tested formulated above suggests three main factors that are likely to influence the mark-up over traffic estimate: 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 number of bidders. Most Auctions have between 2 and 4 bidders. The hypothesis is that the mark-up over traffic estimate will be larger the larger is the number of bidders, i.e. we expect a positive impact of the NUMBER OF BIDDERS variable on our mark-up 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. To examine the potential differences in the effect of the competition across projects, we look at two specific project types, highway and bridge/tunnel concessions, where we think the relative importance of the common-value components differ. Based on the preceding literature on this sector (Hong and Shum, 2002, De Silva et al., 2005) and on discussions with some private concessionaires, we believe that highway construction is relatively straightforward whereas in bridge and tunnel construction, there is more uncertainty on construction costs. Soil conditions at a site may not be fully known until excavation work begins and bridges and tunnels constitute most often technological challenges (we can mention here the examples of the Rion-Antirion bridge, the Millau viaduct and the Prado-Carénage tunnel). The private concessionaires we spoke with generally thought that some costs associated with bridge/tunnel construction were more uncertain that the cost components typically observed in highway projects. 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 HIGHWAY, taking the value 1 if the project is a highway concession, 0 if the project is a bridge or a tunnel concession.

Regarding the likelihood of contractual renegotiation, the institutional framework may serve as a useful guide. To capture the reliability of contract enforcement, we used the indicator HIGH INCOME COUNTRY developed by the World Bank (2006a).

5 Hong and Shum (2002) distinguish three types of jobs in their data set of transportation construction services bids: highway work, bridge construction and maintenance, and road paving. De Silva et al. (2005) in turn distinguish asphalt and bridge works.
The hypothesis is that greater numbers of bidders for projects taking place in stronger institutional frameworks will more likely lead to greater mark-ups over traffic estimate, i.e. to a positive impact of these crossed variables on our mark-up dependent variable, highlighting by the way the effects of the winner’s curse.

In addition, we include in the regressions several control variables that could impact on the bidding behaviour. First, variables that may reflect the effect of projects specificities on traffic forecast accuracy. Three project specific variables are considered: FACILITY LENGTH, INVESTMENT and DELAY. The length of a motorway is related with network effects (as diverted and induced traffic), model assumptions (especially related to the valuation of travel time savings) and the regional impact of the infrastructure. The amount of investments may affect the importance candidates will give to the production of a better traffic forecast but also the bidders’ determination to win the auction. Finally, the variable DELAY, defined as the number of years between the contract year and the completion of the infrastructure concession, captures the increasing uncertainty associated with long time horizons. In fact, an important source of traffic forecast inaccuracy stems from the difficulty of predicting future economic conditions with any confidence. The hypothesis is that longer construction period increases uncertainty, leading to greater traffic forecast errors.

Furthermore, we introduce variables reflecting contracting parties experience. CONCESSIONAIRE EXPERIENCE and GOVERNMENT LEARNING represent the number of road concession contracts each party had signed before the project in question. The hypothesis for the variable CONCESSIONAIRE EXPERIENCE is that more experienced bidders are more cognizant of the winner’s curse (Kagel et al. 1989). GOVERNMENT LEARNING affects the procuring authority expectation of traffic forecasts. The hypothesis is that bidders will take this experience into account and thus less bias their bids when the experience of the procuring authority is important.

Besides, the awarding criteria may affect traffic deviation since it is related to bidders’ strategies. Since most projects are awarded via the lowest toll charged to users, we include in the regression the dummy variable TOLL.

The variables used in our estimations are summarized in the following Table 1 and the correlation matrix is given in Appendix 2.
Table 1: Data Definitions and Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARK-UP</td>
<td>37</td>
<td>0.815</td>
<td>0.237</td>
<td>0.217</td>
<td>1.25</td>
<td>Ratio actual traffic / forecast traffic</td>
</tr>
<tr>
<td>NUMBER OF BIDDERS (NB)</td>
<td>37</td>
<td>3.514</td>
<td>1.677</td>
<td>1</td>
<td>9</td>
<td>Number of bidders for the contract</td>
</tr>
<tr>
<td>HIGHWAY</td>
<td>37</td>
<td>0.703</td>
<td>0.463</td>
<td>0</td>
<td>1</td>
<td>1 if the project is a highway concession; 0 otherwise (i.e. for bridge and tunnel concessions)</td>
</tr>
<tr>
<td>HIGH INCOME COUNTRY (HIC)</td>
<td>37</td>
<td>0.459</td>
<td>0.505</td>
<td>0</td>
<td>1</td>
<td>1 if the country in question is a high income country; 0 otherwise (Source: World Bank)</td>
</tr>
<tr>
<td>LENGTH</td>
<td>37</td>
<td>107.004</td>
<td>127.805</td>
<td>0.5</td>
<td>510</td>
<td>Length of the facility in kilometre</td>
</tr>
<tr>
<td>INVESTMENT</td>
<td>37</td>
<td>429.798</td>
<td>440.963</td>
<td>22.5</td>
<td>1554</td>
<td>Total construction costs in million of euro</td>
</tr>
<tr>
<td>CONCESSIONAIRE EXPERIENCE</td>
<td>37</td>
<td>1.351</td>
<td>2.710</td>
<td>0</td>
<td>13</td>
<td>Number of former toll road concessions of the winning bidder</td>
</tr>
<tr>
<td>GOVERNMENT LEARNING</td>
<td>37</td>
<td>1.162</td>
<td>2.421</td>
<td>0</td>
<td>10</td>
<td>Number of concessions the public authority has awarded before the present project</td>
</tr>
<tr>
<td>TOLL</td>
<td>37</td>
<td>0.541</td>
<td>0.505</td>
<td>0</td>
<td>1</td>
<td>1 if the adjudication criteria is the lowest toll; 0 otherwise</td>
</tr>
<tr>
<td>DELAY</td>
<td>37</td>
<td>2.378</td>
<td>2.178</td>
<td>0</td>
<td>7</td>
<td>Number of years between the contract year and the completion of the infrastructure construction</td>
</tr>
</tbody>
</table>

4. ECONOMETRIC RESULTS

In order to test our three theoretical predictions, we have performed two sets of estimates using OLS models. The first one set of estimates is concerned by log-log regressions while the second set of estimates is concerned by linear regressions. Using the two models is a way to see how robust our results are according to the type of regression. Four models were estimated in each set of estimates. We first analyse the overall impact of the number of bidders on bidding behaviour (Model 1 and Model 5). We then examine the effects of the winner’s curse on contract auctions with differing levels of common-value components (Models 2 and 6). We then identify the impact of the variable HIGH INCOME COUNTRY interacted with NUMBER OF BIDDERS on bidding behaviour in Models 3 and 7. We finally integrate our control variables in order to test for their impact on the mark-up in Models 4 and 8. Results are reported in Table 2.
Table 2: OLS Estimation Results

<table>
<thead>
<tr>
<th></th>
<th>LOG-LOG</th>
<th></th>
<th>LINEAR</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 3</td>
<td>Model 4</td>
<td>Model 5</td>
<td>Model 6</td>
<td>Model 7</td>
<td>Model 8</td>
</tr>
<tr>
<td>NB Bidders'</td>
<td>0.256*</td>
<td>1.451*** (0.126)</td>
<td>1.303** (0.368)</td>
<td>1.192** (0.362)</td>
<td>0.044* (0.022)</td>
<td>0.258** (0.079)</td>
<td>0.221** (0.079)</td>
<td>0.202* (0.080)</td>
</tr>
<tr>
<td>Highway</td>
<td>1.839*** (0.483)</td>
<td>1.793*** (0.466)</td>
<td>1.538** (0.541)</td>
<td>0.934** (0.297)</td>
<td>0.881** (0.289)</td>
<td>0.734* (0.315)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highway*NB Bidders'</td>
<td>-1.266** (0.384)</td>
<td>-1.146** (0.375)</td>
<td>-1.011* (0.410)</td>
<td>-0.228** (0.081)</td>
<td>-0.193* (0.081)</td>
<td>-0.161* (0.084)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIC*NB Bidders'</td>
<td>0.162* (0.084)</td>
<td>0.278* (0.132)</td>
<td>0.038+ (0.021)</td>
<td>0.066* (0.027)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>length</td>
<td>0.059 (0.067)</td>
<td></td>
<td>0.001+ (0.000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>investment</td>
<td>-0.044 (0.062)</td>
<td></td>
<td>-0.000 (0.000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>concep</td>
<td>-0.057 (0.087)</td>
<td></td>
<td>-0.021 (0.016)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>govlearn</td>
<td>-0.006 (0.026)</td>
<td></td>
<td>0.007 (0.016)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>toil</td>
<td>-0.096 (0.120)</td>
<td></td>
<td>-0.028 (0.078)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delay</td>
<td>0.016 (0.116)</td>
<td></td>
<td>0.005 (0.021)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-0.556*** (0.158)</td>
<td>-2.232*** (0.464)</td>
<td>-2.212*** (0.447)</td>
<td>-1.969*** (0.532)</td>
<td>0.660*** (0.089)</td>
<td>-0.186 (0.285)</td>
<td>-0.165 (0.276)</td>
<td>-0.158 (0.329)</td>
</tr>
<tr>
<td>R²</td>
<td>0.105</td>
<td>0.422</td>
<td>0.481</td>
<td>0.539</td>
<td>0.098</td>
<td>0.321</td>
<td>0.385</td>
<td>0.536</td>
</tr>
<tr>
<td>Adj R²</td>
<td>0.079</td>
<td>0.370</td>
<td>0.416</td>
<td>0.361</td>
<td>0.072</td>
<td>0.259</td>
<td>0.308</td>
<td>0.357</td>
</tr>
<tr>
<td>N</td>
<td>37</td>
<td>37</td>
<td>37</td>
<td>37</td>
<td>37</td>
<td>37</td>
<td>37</td>
<td>37</td>
</tr>
</tbody>
</table>

Significance levels: +0.10 * 0.05 ** 0.01 *** 0.001
Standard errors are in parentheses; * 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. Models 1 and 5 show that there is a positive impact of a fiercer competition on the mark-up over traffic estimate. In particular, the elasticity of traffic deviation with respect to the number of bidders is about 0.26. This result corroborates our proposition 1, whatever the econometric model. It means that, overall, the effect of the winner’s curse in toll road concession contract auctions is strong and that common value components in auctions for toll road concessions prevail on private value components.

Besides, we observe that this winner’s curse effect is even larger for projects where the common uncertainty is greater. In fact, while the direct impact on the mark-up of the highway variable is positive – which is consistent with the fact that less uncertain projects lead to less traffic deviation – the highway variable interacted with number of bidders has a negative impact on the mark-up. This means that, compared to bridges/tunnels projects, i.e. compared to more uncertain projects, bidders on highway projects are less cognizant of the winner’s curse. In other words, the larger the relative size of the common-value component, the more cognizant of the winner’s curse bidders are when competition increases.

Results of Models 3 and 7 show that this phenomenon is significantly higher in high income countries. This is consistent with our proposition 3 and this result suggests that strong institutions constitute an important impediment to bidders’ opportunism.

Regarding now the effect of our control variables, we observe that the variables that reflect the effect of projects specificities on traffic forecast accuracy are not significant. The fact that the size of the projects is not significant excludes the hypothesis that bidders would be more opportunists for more important contracts.

When we incorporate in the regressions variables reflecting contracting parties experience, we observe that CONCESSIONAIRE EXPERIENCE has not a significant impact on bidding behaviour. This result contrasts with the findings in the experimental literature (cf. Kagel and Levin, 1986), which find that bidders only learn to internalize the winner’s curse (i.e. bid “rationally”) through experience. Most of the winning bidders of our sample (65%) are inexperienced bidders so that it seems that they have drawn on lessons from the past experiences of the other bidders. GOVERNMENT LEARNING has no significant impact on traffic deviation. Moreover, we observe no statistically significant impact of the variable TOLL.

5. 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, 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, implying the prevalence of common value components on private value components in such auctions. More precisely, we show that the winner’s curse effect prevails on the competitive effect in toll road concession contract auctions so 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 bridges and tunnels projects, i.e. for projects where the common uncertainty is greater.

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 our institutional environment variable, we observe that the effect of the winner’s curse is weaker when the likelihood of renegotiation is higher. This means that bidders will bid more strategically in weaker institutional frameworks, in which renegotiations are easier.

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.

Our analysis leaves many questions open. For instance, it would be interesting to study the pros and cons of auctions and negotiation as methods to award concession contracts (See Bajari et al., 2003, Saussier, 2006, Yvrande 2006). In fact, the above implication sustains only if we assume that the procuring authority chooses to award a concession contract through a competitive tendering. It does not mean that competitive tendering is the best way to award concession contracts.

REFERENCES


Estache A. (2004) *PPI partnerships vs. PPI divorces in LDCs (or are we switching from PPPi to PPDI?)*. Working Paper. World Bank and ECARES.


Appendix 1: Histograms for the regression variables

(a) Mark-up
(b) number of bidders
(c) length (km)
(d) investments (construction costs in million of euro)
(e) Concessionaire experience
(f) government learning
(g) high income country
(h) toll
(i) delay
### Appendix 2: Correlation matrix

<table>
<thead>
<tr>
<th></th>
<th>mark-up</th>
<th>Nb bidders</th>
<th>Highway</th>
<th>HIC</th>
<th>Length</th>
<th>Investment</th>
<th>Government Learning</th>
<th>Concessionaire experience</th>
<th>Delay</th>
<th>Toll</th>
</tr>
</thead>
<tbody>
<tr>
<td>mark-up</td>
<td>1.00</td>
<td>0.31</td>
<td>0.24</td>
<td>0.10</td>
<td>0.31</td>
<td>0.14</td>
<td>0.10</td>
<td>-0.01</td>
<td>-0.31</td>
<td>-0.03</td>
</tr>
<tr>
<td>Nb bidders</td>
<td>0.31</td>
<td>1.00</td>
<td>-0.01</td>
<td>-0.02</td>
<td>-0.16</td>
<td>-0.09</td>
<td>0.01</td>
<td>0.04</td>
<td>-0.19</td>
<td>0.29</td>
</tr>
<tr>
<td>Highway</td>
<td>0.24</td>
<td>-0.01</td>
<td>1.00</td>
<td>-0.47</td>
<td>0.52</td>
<td>0.08</td>
<td>-0.03</td>
<td>0.00</td>
<td>-0.52</td>
<td>0.23</td>
</tr>
<tr>
<td>HIC</td>
<td>0.10</td>
<td>-0.02</td>
<td>-0.47</td>
<td>1.00</td>
<td>-0.50</td>
<td>0.38</td>
<td>0.32</td>
<td>0.37</td>
<td>0.44</td>
<td>-0.13</td>
</tr>
<tr>
<td>Length</td>
<td>0.31</td>
<td>-0.16</td>
<td>0.52</td>
<td>-0.50</td>
<td>1.00</td>
<td>-0.11</td>
<td>-0.12</td>
<td>-0.13</td>
<td>-0.53</td>
<td>-0.03</td>
</tr>
<tr>
<td>Investment</td>
<td>0.14</td>
<td>-0.09</td>
<td>0.08</td>
<td>0.38</td>
<td>-0.11</td>
<td>1.00</td>
<td>0.07</td>
<td>-0.06</td>
<td>0.13</td>
<td>0.25</td>
</tr>
<tr>
<td>Government Learning</td>
<td>0.10</td>
<td>0.01</td>
<td>-0.03</td>
<td>0.32</td>
<td>-0.12</td>
<td>0.07</td>
<td>1.00</td>
<td>0.55</td>
<td>0.21</td>
<td>-0.16</td>
</tr>
<tr>
<td>Concessionaire</td>
<td>-0.01</td>
<td>0.04</td>
<td>0.00</td>
<td>0.37</td>
<td>-0.13</td>
<td>-0.06</td>
<td>0.55</td>
<td>1.00</td>
<td>0.17</td>
<td>-0.08</td>
</tr>
<tr>
<td>experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delay</td>
<td>-0.31</td>
<td>-0.19</td>
<td>-0.52</td>
<td>0.44</td>
<td>-0.53</td>
<td>0.13</td>
<td>0.21</td>
<td>0.17</td>
<td>1.00</td>
<td>-0.12</td>
</tr>
<tr>
<td>Toll</td>
<td>-0.03</td>
<td>0.29</td>
<td>0.23</td>
<td>-0.13</td>
<td>-0.03</td>
<td>0.25</td>
<td>-0.16</td>
<td>-0.08</td>
<td>-0.12</td>
<td>1.00</td>
</tr>
</tbody>
</table>