UNIVERSITÉ DE PARIS I – PANTHEON – SORBONNE

U.F.R. de SCIENCES ÉCONOMIQUES

UNCERTAINTY, RENEGOTIATION, AND INCENTIVES IN PUBLIC PRIVATE PARTNERSHIPS

An Economic Analysis of Worldwide Toll Road Concessions

THÈSE POUR LE DOCTORAT EN SCIENCES ÉCONOMIQUES

présentée et soutenue par

LAURE ATHIAS

le 23 novembre 2007

Directeur de Thèse

M. LE PROFESSEUR STÉPHANE SAUSSIER
(Université de Paris XI – Paris Sud)

Rapporteurs

M. LE PROFESSEUR EDUARDO ENGEL
(Yale University)

M. LE PROFESSEUR GUY GILBERT
(Ecole Normale Supérieure de Cachan)

Suffragants

M. DAVID AZÉMA
(Directeur Général de Vinci Concessions)

M. LE PROFESSEUR JÉROME GAUTIÉ
(Université de Paris I – Panthéon – Sorbonne)

M. LE PROFESSEUR CLAUDE MÉNARD
(Université de Paris I – Panthéon – Sorbonne)

ACKNOWLEDGEMENTS

To my parents, Sandrine, Cécile, Corinne and my uncle Claude

I wish to thank to all who have helped me along the way. Stéphane has been a source of happiness, and without his uncompromising love and support, I would have been miserable. I would also have been deported for failing to do my tax reports.

Stéphane Saussier, my adviser, has been relentless in trying to extract the most out of me. His energy, careful readings, discussions, criticisms and encouragements have been immeasurable. He has also greatly helped me by being my co-author in one paper that has served as a basis for my discussion in this dissertation. I am tremendously indebted to him.

I am also tremendously indebted to Vincent Piron and David Azéma. Without their willingness to foster mutual understanding between town and gown, between practice and theory, between two worlds between which there is most often, in particular in France, no intercourse and no sympathy, this thesis would not have been possible. This open-mindedness is only a pale reflect of their outstanding intelligence.

I am also very grateful to Eduardo Engel, who gave me the opportunity to be a visiting scholar at Yale for one semester. The interaction with him while being at Yale has been a privilege. His scepticism has forced me to think harder and write more clearly about my research.

I have also learnt a lot from Claude Abraham, Eric Brousseau, Pierre-Louis Delseny (not only but also about jazz music!), Pierre Garrouste, Jean-Michel Glachant, Armelle Mazé, Claude Ménard, Yannick Pérez, Rémy Prud'homme, Emmanuel Raynaud, Carine Staropoli and last but not least Anne Yvrande-Billon. Their comments, knowledge and experience have been most precious in widening my perspective.

Working with Antonio on our endless paper has been a very enriching and fun experience.

I am grateful to a few other colleagues at ATOM. In particular Eshien – I will not forget our nice wandering about the streets of Barcelona, Aleksandra, Alexandra, Annie, Claudine, David, Freddy, Jean-Michel, Marie-Joëlle, Miguel, Milena, Olivier, and Jean. I also want to thank those from elsewhere for the nice time spent together: Galina, Frédérique (I will not forget the Turkish baths in Buda), Charles, Mathieu, Pierre, and Nicolas.

Finally, I thank my friends who have been supporting me unconditionally, especially Flip, Janfi, John and Marco, Maher, Ménie, Morgan, Roulienne, Tony, and Vanessa.

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[It is an empirical fact the natural sciences have progressed only when they have taken secondary principles as their point of departure, instead of trying to discover the essence of things ... Pure political economy has therefore a great interest in relying as little as possible on the domain of psychology].

Pareto letter 1897, quoted in Camerer 2007, C26

INTRODUCTION AND OVERVIEW

An analogy to organisational economics illustrates the potential of public private partnership economics. Coase, in his seminal 1937 article, raises the question of why firms exist and the necessity of opening up the black-box of the firm. Nevertheless, until the 1970s, the "theory of the firm" was basically a reduced-form model of how capital and labour are combined to create a production function. The idea that a firm merely combines labour and capital neglects the details of principal-agent relations, social networks, substitution of authority for pricing, corporate culture and so forth. Later, contract theory opened up the black-box of the firm and modelled the details of the nexus of contracts between shareholders, workers and managers. The new theory of the firm tackles the firm with a more detailed account of how components of the firm – individuals, hierarchies and networks – interact and communicate to determine firm behaviour.

Public private partnership economics proposes to do the same. The seminal paper of Demsetz (1968) popularized the idea suggested by Chadwick (1859) that it is possible to use franchise bidding mechanisms to introduce competition into industries where it is precluded by market conditions. Under such a mechanism, auctions are organized by a public authority to attribute temporary monopolistic market rights to a private firm, *via* a contractual arrangement between the public entity and the private firm. Such competition should therefore be beneficial, first by avoiding the productive inefficiency of the public sector[1], and second by limiting market power conferred by such contracts on the chosen private operator. Williamson (1976), Goldberg (1976), and Goldberg (1977), using transaction cost economics arguments, pointed out that potential problems may arise at the different contractual stages, mainly due to the very-long term dimension of such contracts, which inevitably creates the need for *ex post* unanticipated service adaptations, and to the fact that these services often require some specific investments. Such *ex post* adaptations leave room for eventual opportunistic behaviour, from both the public and the private partner. Given this, one might have expected the literatures to have gone further along these lines and pay further attention to the details – in terms of collusion, winner's curse, corruption, contractual design, incentives to innovate, renegotiation, political accountability and so forth – of the particular organisational form of the provision of public services that is the Public Private Partnership (PPP). Many definitions have been proposed for the concept of PPP. The National Council for PPPs in the United States defines a PPP as: "A contractual agreement between a public agency and a private sector entity whereby the skills and assets of each […] are shared in delivering a service or facility for the use of the general public. In addition […] each party shares in the risks and reward potential […]". Other definitions lay more the emphasis on the fact that in a PPP the government buys services whereas in a conventional arrangement the government buys a physical asset (e.g. Grimsey and Lewis 2004).

However, until the end of the 1990s, this was not so. A first stream emerged then on the question of when public or private provision of public services is optimal, adopting either a public finance perspective (Engel, Fischer and Galetovic 1997 and 2007, Grout and Sonderegger 2006), or a complete contracting perspective, in which imperfections arise

[1] Many empirical studies of the relative performances of public and private enterprises done in the past thirty years find significantly superior performance by private enterprises, at least with respect to productive efficiency (e.g. Megginson and Netter (2001), Kikeri and Nellis (2002)). On the theoretical side, Vickers and Yarrow (1991) point out that private ownership results in better performance mainly because, *inter alia*, management has better incentives to enhance the performance under private ownership. Boycko, Shleifer and Vishny (1996) develop the argument that private management is shielded from vagaries of political interference, and therefore may lead to management practices that are more market-oriented that enhance efficiency.

because of moral hazard or asymmetric information (Laffont and Tirole 1993, Bentz, Grout and Halonen 2004, Martimort and Straub 2006), or an incomplete contracting perspective, in which inefficiencies arise because it is hard to foresee and contract about the uncertain future (Schmidt 1996, Grout 1997, Hart, Shleifer and Vishny 1997, Besley and Ghatak 2001, Bennett and Iossa 2002, Hart 2003, Levin and Tadelis 2007). Later, public private partnership economics opened up the black-box of the PPP and modelled how components of the PPP – the private operator, the public authority, and networks – interact and communicate to determine the PPP efficiency.

The late focus of the literatures on this particular contractual arrangement between a public entity and a private sector entity for the provision of a public service is all the more surprising that PPPs began to emerge in practice significantly by the middle of the 1970s. In 1974, Chile launched the first large scale private participation in infrastructure. In Mexico, PPPs were first used in the 1980s to finance highways. About 10 years later, Argentina replicated the experience. As highlighted by Estache (2006), “within 20 years of Chile’s policy experience, it seemed that all developing countries from the poorest countries of Africa to the richest countries of East Asia were at least flirting with the idea and often wed to it. Between 1984 and 2003, private participation in infrastructure generated investment commitments of about US$790 billion”. The following Table 1 provides a snapshot of the adoption of public private partnerships in infrastructure (PPPI) throughout the developing world. It shows the total level of private sector commitments in infrastructure, the number of projects and the investment per capita for the period 1984-2002.

Table 1: Selected Indicators of Regional Distribution of PPPI

	Total investment commitment (US$ billion)	Number of Projects	Average Project Size (in US$ million)	Accumulated Investment commitment per capita as of 2002 (in US$)
East Asia	182	687	265	99
Eastern Europe	100	589	169	211
Latin & Central America	368	978	376	694
Middle East	24	64	312	79
South Asia	42	195	213	29
Sub-Saharan Africa	26	213	122	38
Total	741	2726	272	141

Source: Estache (2006)

In developed countries, partnerships between the public and private sectors for the delivery of a service or facility for the use of the general public go back to the 16th century in

France (to 1554, more precisely, with the contracting out of the design, building, financing, and operation of the Craponne canal), and to the 1980s in the United Kingdom where they constituted an element in the broader process of privatization undertaken by the Thatcher government, before the implementation of the Private Finance Initiative (PFI) program, which began in 1992. The PFI is currently responsible for about 14% of public investment (HM Treasury 2003). Other countries with significant PPP programs include Australia and Ireland. PPPs in Europe, including the United Kingdom, accounted in 2000 and 2003 for 85% of PPPs worldwide (PricewaterhouseCoopers 2004) and concern a broad range of public services (roads, bridges, schools, hospitals, prisons, government accommodation, computer systems, Ministry of Defence training simulators, and other activities).

This gap between theory and practice has begun to be filled mainly when many of the experiences turned sour. Estache (2006) raises the question whether public private partnerships were turning out to be public private divorces. In fact, after reaching a peak of US$131 billion in 1997, PPI commitments have however steadily dropped and reached less than US$50 billion in 2003 in less developed countries (World Bank PPI Database). This is a strong indication that many of the relationships have gone sour.

In Latin America for instance, Guasch (2004) shows that roughly 50% of the concession contracts signed since the mid 1980s ended up being renegotiated shortly after the award of the concession. The potential for renegotiation of PPPs is highlighted also in developed countries (Gomez-Ibanez and Meyer 1993, Engel *et al.* 2003, 2005 and 2006), and clearly contributes to the inefficiency of PPPs. While some renegotiation is desirable and is to be expected as contracts are in practice necessarily incomplete – exogenous events that are not induced by either the government or the operator (like currency devaluation) can significantly affect the financial equilibrium of firms, and can be used as an opportunity to redistribute rents –, the high incidence of renegotiations, particularly in early stages, appears to be beyond the expected or reasonable levels, and raises concerns. It might induce excessive opportunistic behaviour by the operators, or by the government, in detriment to the efficiency of the process and overall welfare. This has been emphasized by the 2001 World Development Report (World Bank 2001), which stresses that "there is a growing consensus that regulation, particularly in poor countries, must be designed with an appreciation of both information asymmetries and difficulties of enforcement". The inherent contractual incompleteness of PPPs (Williamson 1976, Aghion *et al.* 1994, Hart 1995) – the reasons invoked for which are contractual transaction costs, bounded rationality of players or information asymmetry between the contracting parties and the judicial system –, the potential incentives for political incumbents to use renegotiation to anticipate infrastructure spending and thereby increase the probability of winning an upcoming election (Engel *et al.* 2006), and the perceived leverage of the enterprise *vis à vis* the government in a bilateral negotiation (Williamson 1985) constitute powerful potential factors to seek renegotiation of the contract and secure a better deal than the initial one.

Paradoxically enough, other stringent worries with PPPs concern the *ex post* adaptation inflexibilities inherent to these long-term contracts. Adaptation is important when consumers' preferences change and improved policies or technologies are discovered. For example, it is difficult to get a good idea of what reasonable standards of quality will be like in 20 or 30 years time. In many university accommodation contracts, the quality standards mention microwave cookers which could not have been written into a contract 20 years ago (McWilliam 1997). As the major feature of PPPs is that they are long-term service contracts, it is highly likely that contracting parties will be unable to write complete contracts that cover all contingencies, and numerous are the cases that offer good illustrations of the difficulties for procuring authorities to reaching an agreement with private public-service providers on contractually unanticipated service adaptations. It is often noted that "[a] key concern with long-term PPP contracts is the level of flexibility that they offer to authorities to make changes either to the use of assets or to the level and type of services offered" (PricewaterhouseCoopers 2005). Renegotiation of contracts avoids this problem but generates inefficiencies. If there is likely to be renegotiation, then residual rights (which follow ownership) will have a significant impact on the outcome and drive the ownership decision. Hart *et al*. (1997) show that if assets are owned by the private sector, then cost-reducing changes can be introduced without renegotiation, since the sole contract with the public sector is on services. Thus the full benefit of such changes flows to the private owner and encourages efficiency. In contrast, benefits that improve service quality require renegotiation and the public body may be in a position to extract part of the benefit since the private owner has no alternative purchaser for the incremental gain. The effect is that the private owner receives less of the benefit of such changes and the incentives are weakened. *The implication is that PPP may lead to inefficient development over time even with renegotiation.* As a consequence, Hart (2003) advocates that, where build contracts are easy to specify but service contracts are not, then it is useful to have a conventional provision ("unbundling" of the construction and operation stages). At the other extreme, where service contracts are easy to write and build contracts are difficult, the PPP approach may be particularly sensible. Bennett and Iossa (2006), in turn, show that PPPs will be optimal only when the innovation in the construction stage has a positive externality on operation and maintenance costs.

Thus, the experience now allows us to open up the black-box of PPPs and observe their effects directly. These direct observations can only enhance the development of theories which are based on more accurate assumptions and make better predictions as a result. For instance, the procurement and regulation literature considers a high level of enforcement of contracts so that renegotiations can be considered as secondary at least as a first approximation (see for exceptions Laffont 2005, Guasch, Laffont and Straub 2006). On the contrary, it appears that renegotiation is an important phenomenon calling for both theoretical and empirical analysis.

The present dissertation, in line with this approach, seeks to contribute to a better understanding of public private partnerships, and hence raises the question of how the public authority can gain the benefits expected from greater productive efficiency of private provision. In particular, we will focus on a specific type of PPP: toll road concessions. The reasons of such a focus are numerous. First, theory and empirics show that the PPP model will not bring the same efficiency gains according to the sectors, and projects within sectors. This suggests that the approach of looking to PPPs for all public-sector projects may be inefficient. Focusing on sectors and project types within sectors for careful analysis may be a far better strategy.

Second, the stakes involved in such PPPs cannot be overstated: 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 and Straub 2003). There are several empirical studies illustrating the impact of infrastructure on economic growth, among the more recent are Canning (1998), Calderon, Easterly and Serven (2003), 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). The "infrastructure gap" in Europe (PPP Green Paper of the European Union 2004) has also been recognised for many years and its negative impact on economic growth, job creation and social cohesion is felt across every country within the region. Thus infrastructure matters and quite significantly. In addition, within infrastructure services, the transport sector, and above all the roads subsector, is one of the most concerned by the involvement of the private sector, as highlighted by the following Tables 2 and 3 for low and middle income countries, and by a study of PricewaterhouseCoopers (2004) that indicates that PPPs in most of European countries are dominated by road projects.

Table 2: Infrastructure sectors ranked by number of PPP projects, 1990-2005

Sector	Project Count
Energy	1,309
Transport	878
Telecom	749
Water and sewerage	476

Source: World Bank PPI database

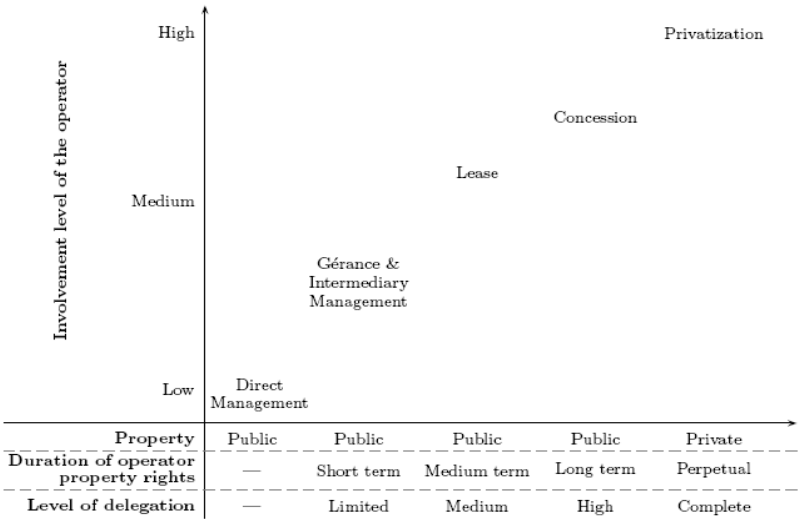
Table 3: Number of PPP projects and investment in projects by transport subsectors (US$ million)

Subsector	Project Count	Total Investment
Airports	118	25,552
Railroads	97	33,700
Roads	476	84,720
Seaports	297	32,644

Source: World Bank PPI database

Also, as highlighted by the following Figure 1 in the particular case of France as of 2003, PPPs include a wide range of contractual arrangements that differ in terms of allocation of decision prerogatives, investment obligations, risks, and revenues across the public and private partners (Grout and Stevens 2003). Among these different PPP types, concession contracts, which have broadly the same meaning everywhere, appear to be the most important to study, since, first, they are the form of PPP that involves the private operator more than any other one[2] and, second, they account for most PPPs around the world. According to the World Bank PPI database, between 1990 and 2000, overall 65% of the projects in Latin America and the Caribbean were adjudicated as concessions. More generally, they account for 54% of all the PPPs developed in low and middle income countries, and for most PPPs in the road sector (57% of the projects in the road sector in the World Bank PPI database are concession contracts). The traditional model of PPPs in the world has therefore been the concession contract.

Figure 1: The different forms of PPP in France as of 2003



Source: Huet and Saussier (2003)

Third and finally, toll road concessions should deserve a special attention because they are particularly prone to the difficulties inherent to PPPs. More specifically, 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. They are very long-term contracts (often over 30 years) involving large upfront specific investments, and a degree of uncertainty that is much greater than in most ordinary contracts. Indeed, traffic forecasts are notoriously imprecise, making toll road concessions very risky. This fact, combined with informational asymmetries, implies that 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 auctioned contract value, may be particularly pronounced within toll road concession auctions. These particular features

[2] In a concession contract, the private provider builds, operates and maintains the facility at its own risk for the whole contract period.

of toll road concessions make them particularly prone to opportunism and renegotiation. While Guasch (2004) also found, in a study on more than 1,000 concession contracts awarded during the 1990s in Latin America, 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, the World Bank PPI database indicates that 38 projects in the road sector are cancelled or under distress representing 13% of total investment in this sector. Moreover, the trend around the world has been increasingly to replace concession contracts by contracts in which the private provider does not bear the demand risk, such as availability contracts. This is particularly pronounced in Europe, where countries have recently promulgated guidelines so as to bring in the availability contract as an alternative to the concession contract, e.g. the June 2004 act in France instituting the new "contrats de partenariat". Thus, there has been an increasing dissatisfaction with concession contracts in recent years, which strengthens the relevance of such a focus.

Considering on the one hand the factual elements discussed above on the inherent difficulties of PPPs in general and of toll road concessions in particular, and on the other hand the various arguments that explain that PPPs can particularly be prone to difficulties, three ways of questioning naturally emerge:

i) Are toll road concessions really prone to winner's curse and renegotiation issues?

ii) What are the effects of uncertainty and renegotiation issues on the contractual design of toll road concessions?

iii) Is the trend towards the adoption of contracts in which the private operator does not bear the demand risk, to avoid the winner's curse and renegotiation issues, an optimal solution?

It is obvious that these three questions are not the only one to be raised regarding the efficiency of toll road concessions. In particular, an important limit to toll road concession auctions could be the occurrence of collusion. Indeed, recent studies have shown that collusion may be a pervasive problem in auctions concerning public contracts in general. For instance, Porter and Zona (1993) have econometrically established bid rigging in auctions for highway construction contracts. Competition authorities on both sides of the Atlantic have also detected several cases of cartel behaviour in auctions for public contracts. In the European Union, for instance, the Swedish Competition Authority exposed a cartel in procurement contracts of road-surfacing (Swedish Competition Authority 2003, 2005).

Likewise, the French Competition Authority recently convicted three firms in the public urban transportation sector for market sharing between 1996 and 1998 (Conseil de la Concurrence 2005b) and five firms for collusion in road construction markets between 1991 and 1998 (Conseil de la Concurrence 2005a). So far, no empirical study proved that collusion actually occurred during auctions for any PPP. Needless to say that collusion would undermine the efficiency of such contracts. However, toll road concession contracts are long-term contracts and Chong (2007) shows that collusion is hardly sustainable when contracts are long-term contracts. We believe then that the three questions raised above are the most important ones considering the specificities of toll road concessions.

Thus, the purpose of the dissertation is to explore the question of the efficiency of PPPs in general, and toll road concessions in particular, under the lens of the three questions raised above. It aims then to contribute, at the theoretical and at the empirical level, to a better understanding of the PPP phenomenon, by bringing new insights into each of these three questions. In what follows, we decline more precisely the questions to which the dissertation attempts to answer and we precise the approach adopted.

Are toll road concessions really prone to winner's curse and renegotiation issues?

So far, the literature has always assumed – with theoretical background –, that the major problems with toll road concessions are the inaccuracy of traffic forecasts, informational asymmetries and the high incidence of renegotiation associated with them. We are aware of no empirical studies that quantify the bid effects of uncertainty, informational asymmetries, and renegotiation in auctions for PPPs in general, and toll road concessions in particular. Studies related to this topic have focused on the various possibilities to overcome these inherent difficulties. Nevertheless, it seems crucial to show, before considering potential solutions, that uncertainty about future traffic, informational asymmetries and renegotiation are in fact the major problems associated with toll road concessions; that is are in fact major issues to tackle when one considers such a type of PPP. This is what the first chapter of this dissertation proposes to do, with an original approach.

An important result of auction theory is that in common value auctions, *i.e.* in auctions in which the competing bidders are differentially (but incompletely) informed about the value of the auctioned contract, an increase in the number of bidders can encourage more conservative bidding, instead of more aggressive bidding. As a matter of fact, a distinctive feature of common value auctions is the winner's curse, defined again as an adverse-selection problem which arises because the winner tends to be the bidder with the most overly-optimistic information concerning the contract's value. Thus, bidding naively based on one's information would lead to negative expected profits, so that in equilibrium, a rational bidder internalizes the winner's curse by bidding less aggressively. Bidders must then bid more conservatively the more bidders there are, because winning implies a greater winner's curse (Milgrom 1989, Bulow and Klemperer 2002, Hong and Shum 2002, Haile, Hong and Shum 2003, Hendricks, Pinkse and Porter 2003).

Thus, one way to quantify the importance of uncertainty and information asymmetries in toll road concessions is to consider the bidding behaviour of bidders for such contracts, and to test whether they are cognizant of the winner's curse. Such an approach also permits testing whether toll road concessions are particularly prone to opportunistic renegotiations. In fact, imperfect enforcement leading to renegotiations can strongly question the results of auction theory, which 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 forward looking bidder that the contract price may later be subject to profitable renegotiation, rendering it possible to avoid any losses, so that there is no point any more in internalizing the winner's curse (Milgrom and Weber 1982). This realization encourages lowballing, that is the submission of bids containing promises difficult to satisfy, with the sole purpose of being awarded the tender (Dasgupta and Spulber 1990).

To this end, we collected original data, although very difficult to obtain, on the difference between the actual traffic and the traffic forecast included in the winning bids, for 49 worldwide toll road concession contracts. We use then 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. To further examine the possible effects of information dispersion and renegotiation, we self-collected data on the characteristics of projects and contracting parties, on the public policy regarding the public release of traffic forecasts prior to bidding, and on institutional and legal frameworks.

The results indicate 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. Moreover, we find that the winner's curse effect is stronger in auctions with a greater degree of common uncertainty. We highlight therefore the bid effects of uncertainty and information dispersion over the value of a contract, which has been largely ignored. Finally, we show that concession contracts are really prone to opportunistic renegotiations, since we observe that bidders less internalise the winner's curse when they expect a higher likelihood of renegotiation.

The first chapter emphasizes that the major problems with toll road concessions are, in fact, the uncertainty and informational asymmetries about future traffic and opportunistic renegotiations. One way to tackle these issues is to adapt the contractual design of such contracts accordingly. Another way is not to impose the demand risk on the private provider, but this solution will be considered in the third chapter of this dissertation.

What are the effects of uncertainty and renegotiation issues on the contractual design of toll road concessions?

In the second chapter, we explore the contractual design of toll infrastructure concession contracts. We highlight the fact that the contracting parties try to sign not only complete rigid contracts in order to avoid renegotiations but also flexible contracts in order to adapt contractual framework to unanticipated contingencies. This gives rise to a tradeoff between contractual flexibility and rigidity.

Such a tradeoff is formalized with a simple model mixing incomplete contract theory (Hart 1995) and transaction cost theory. More precisely, we propose an incomplete contract theory model with renegotiation and maladaptation costs, permitting us to study alternative contract forms in a refined incomplete contract framework.

The grounds of such an approach follow from the specificities of PPPs. As already highlighted, PPPs are incomplete contracts, hence subject to *ex post* adaptations. These adaptations may result in higher surplus or better service quality delivered by the private operator. It is then crucial to design such contracts so as to favour their adaptation; that is to provide the private provider with the right incentives to adapt the contract accordingly, since the private provider has residual control rights over the way the service is provided. Since such adaptations/innovations could not be foreseen when the initial contract was designed, bargaining may take place over the splitting of the surplus from implementation of the innovations. The private provider's anticipation of the outcome of such bargaining affects its incentive to research possible innovations, and its anticipation will depend on the contractual design (flexible or rigid). The framework proposed by the incomplete contract theory seems therefore to fit well with public private contracts. However incomplete contract theory narrowed the focus on one type of transaction cost – the hold-up problem. Thus, in this theoretical framework *ex post* bargaining is always efficient. Nevertheless, PPPs in general, and toll road concessions in particular, are characterized by a high uncertainty and incidence of renegotiation. This is the reason why we consider also two different kinds of transaction cost in our model: maladaptation costs due to misalignment of the contract with states of nature, and renegotiation costs, namely haggling and friction due to *ex post* changes and adaptations when contracts are incomplete. In contrast to the previous literature on this topic (Crocker and Masten 1991, Crocker and Reynolds 1993, Bajari and Tadelis 2001), we assume that these renegotiation costs are not a function of the contractual design, since, as highlighted in the first chapter, renegotiation are most often not Pareto improving.

This approach is original to the extent that previous works using an incomplete contract framework focus on the make or buy issue, opening the way for critics saying that the incomplete contract theory is only a property right theory and has nothing to say about alternative contractual choices (Masten and Saussier 2002). We show that this is not necessarily the case. Furthermore, our results highlight the fact that tradeoffs are complex and do not correspond to previous propositions coming from a transaction cost framework (Crocker and Masten 1991, Crocker and Reynolds 1993). More precisely, those previous works generally argue that there is a monotonic relationship between asset specificity and the use of rigid contracts. We highlight the fact that this proposition may be true, but only if other conditions concerning maladaptation costs, renegotiation costs and the probability to see the contract enforced are met.

To test our propositions, we constructed an original database consisting of 71 worldwide toll road concession contracts. We address the issue by focusing on the question of how parties adjust prices – tolls – in toll road concession contracts. This approach is in line with previous studies that catch on the contractual flexibility/rigidity through the price provision (Crocker and Masten 1991, Crocker and Reynolds 1993, Bajari and Tadelis 2001), and with the particularities of toll road concessions for which the uncertainty, mainly on future traffic, will be mostly tackled through the design of Toll Adjustment Provisions (TAP), which consist in determining *ex ante* the tolls that can be charged to users *ex post*. We complement the data on the design of toll adjustment provisions with data gathered from contracts and other sources that describe the type of concessionaires, the traffic uncertainty and the complexity surrounding each project, the number of bidders, the country institutional framework, the experience of the public authority, the number of repeated interactions between the concessionaire and the public authority, political leanings, and so forth.

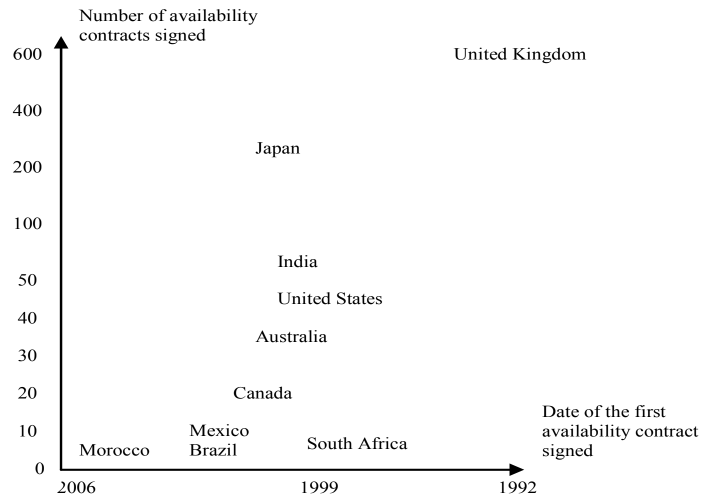
We show, in contrast to many papers that often assume the rigidity of PPPs, that this rigidity seems to be the exception rather than the rule regarding toll adjustment provisions. Indeed, we observe in our sample a great variety of toll adjustment provisions, from very rigid ones such as firm-fixed price provision in which tolls are fixed for the whole length of the concession, to very flexible ones with the so-called renegotiation provisions, which consist in determining *ex ante* periodic *ex post* negotiations of the toll adjustment provision initially chosen. In addition, our results suggest an important role for economic efficiency concerns, as well as politics, in designing toll road concession contracts. In other words, we show that the predictions of the model are corroborated by our empirical findings. This suggests that contracting parties do take into account uncertainty and renegotiation issues when designing toll road concession contracts.

Is the trend towards the adoption of contracts in which the private operator does not bear the demand risk, to avoid the winner's curse and renegotiation issues, an optimal solution?

As already mentioned, another way to deal with the problems of uncertainty, informational asymmetries and renegotiation inherent to toll road concessions is to not impose the demand risk on the private provider, as highlighted by the works of Engel, Fischer and Galetovic (1997, 2001, 2003, and 2007).

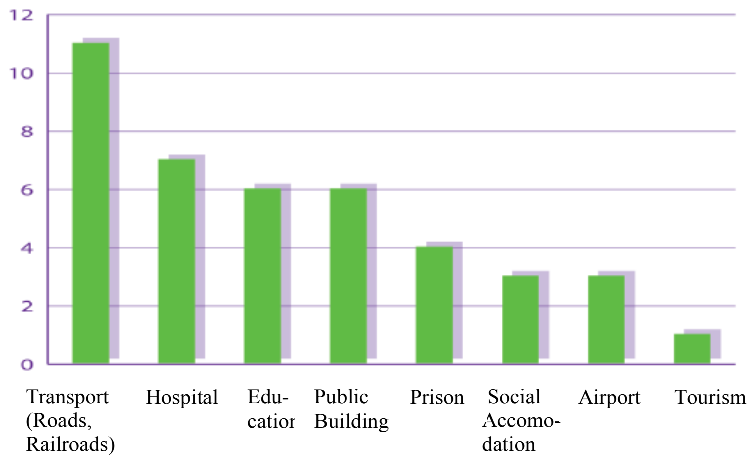
The fact is that the trend around the world has been increasingly to adopt availability contracts to move away from the concession model. The availability contract, as the concession contract, is a long-term, global, fixed-price contract on the design, building, financing and operation of a public service and consists in output specifications systems. As the concession contract, it also formally delegates to the private provider sufficient residual control rights to provide the service free of interference. The main difference between these two contractual practices concerns the demand risk, which is borne by private providers in the concession contract and by procuring authorities in the availability contract. Thus, under a concession contract, the private provider's remuneration depends on the demand for the public service whereas under an availability contract, it comes from service payments by the procuring authority according to performance criteria (the contract specifies penalties in case the performance and quality criteria are not met; there is therefore no link with the service demand). The following Figures 2 and 3 show that this trend towards the adoption of availability contracts concerns countries of the five continents, even though it is particularly pronounced in Europe, with the leading figure of the United Kingdom which launched availability contracts – designated by the acronym PFI "the Private Finance Initiative" – in 1992, and all public services.

Figure 2: The development of availability contracts in a sample of 12 countries



Source: Ernst & Young 2006
Note: France and China are excluded from the sample.

Figure 3: Distribution of availability contracts by sector in the same sample of 12 countries (by number of countries concerned for each sector)



Source: Ernst & Young 2006

As theory and practice so far seem to converge towards the fact that contracts in which the private provider does not bear the demand risk solve many of the difficulties inherent to toll road concessions, a major question is therefore the following one: Are availability contracts, or more generally contracts in which the private provider does not bear the demand risk, a better option for contracting-out to a private provider the provision of public services than concession contracts?

As already highlighted, stringent worries regarding PPPs in general and toll road concessions in particular concern the *ex post* adaptation inflexibilities inherent to these long-term contracts. So far, as already discussed, studies (except Ellman 2006) have explained the *ex post* adaptation problems by the distorted incentives for the private public-service provider to invest in the research into innovative approaches to carrying out the service provision (Hart, Shleifer and Vishny 1997, Hart 2003, Bennett and Iossa 2006). None of them approach this issue from a political accountability point of view; none of them give an active role to public authorities. However, public authorities have also an important role to play in the adaptation of the private provision of public services, to the extent that there is no direct accountability of private providers to consumers. The importance of the role of public authorities in the delegation of the provision of public services to private providers was pointed out by David Hinchliffe[3], according to whom: "[T]he key to reforming the public sector is not the profit motive, but democracy and accountability".

Ellman (2006) is the first to theoretically raise the question of the accountability of public authorities in the adaptation over time of the private provision of public services. More precisely, in this paper, the author compares *private* with *public* provision regarding political and public accountability.

By contrast, in this third chapter, we propose to investigate how the contractual design of PPPs – availability *versus* concession contracts – affects not only the incentives of the private provider to adapt the service provision, but also, and above all, the incentives of public authorities to be responsive to consumers concerns. To this aim, we present an incomplete contract theory model in which: (1) public authorities (e.g. government, mayors) are involved in adaptation, *i.e.* exert effort to respond to consumers demands; (2) consumers may have the power to oust the private manager; (3) private providers exert efforts to cut costs, which has a pervasive effect on quality, and to discover adaptations.

[3] David Hinchliffe, Chair, House of Commons Health Select Committee, in Pollock, Shaoul and Player (2001).

We show that public authorities end up having to pay more for unanticipated desirable service adaptations when the private provider does not bear the demand risk than when it does. This is due to the fact that under a concession contract consumers are empowered, *i.e.* have the ability to oust the private provider, which provides procuring authorities with more credibility in side-trading and thus greater incentives to be responsive. We also point out that concession contracts can provide greater adaptation effort incentives to private providers than availability contracts. This is due to the fact that there might be private gains from implementing the adaptation under a concession contract, so that the private provider will implement the adaptation without any further inducement.

As a consequence, we show that there is a lower matching with consumers preferences over time under an availability contract than under a concession contract. In other words, we show that contracts in which the private provider does not bear the demand risk rule more out the accountability – regarding service adaptations – of public authorities and providers to individual consumers than when the private provider bears the demand risk.

The striking policy implication of this chapter is that the trend towards a greater resort to availability contracts, or more generally to contracts in which the private provider does not bear the demand risk, instead of concession contracts, so as to reduce their intrinsic uncertainty and renegotiation issues, may not be optimal.

The questions to which the dissertation attempts to answer, the approaches adopted, the data used, and the main results obtained are summarized in the following table.

Table 4: Summary of the questions, theoretical approaches, data and results

	Approach	Sources of data	Main results
Chapter 1 Number of bidders, information dispersion, renegotiation and winner's curse in toll road concessions	- Estimation of bidders' behaviour in toll road concession auctions. (OLS and Maximum Likelihood Estimation)	- Traffic counts, private providers, public authorities, regulators, scientific and professional press. - N= 49 - 13 countries represented - Period covered: 1989-2003.	- Strong winner's curse effect in toll road concession auctions. - Stronger winner's curse effect in toll road concession auctions with a greater degree of common uncertainty. -Weaker winner's curse effect in toll road concession auctions with a higher likelihood of renegotiation.
Chapter 2 Contractual flexibility or rigidity for public private partnerships? Theory and evidence from toll road concessions	- Formalization of the choice between contractual flexibility and rigidity for the design of public private partnerships, mixing incomplete contract theory and transaction cost theory approaches. - Estimation of the contractual choices in the design of toll adjustment provisions in toll road concessions. (Ordered Logit)	- Private providers, scientific collaborations, public authorities. - N=71 - 8 countries represented - Period covered: 1970-2005	-Theoretical results: . the higher the maladaptation costs, the more efficient a flexible contract. . the higher the likelihood of exogenous renegotiation, the more efficient a flexible contract. . the higher the level of asset specificity, the less efficient a flexible contract. . the higher the renegotiation costs, the less efficient a flexible contract. - Empirical results: corroborate the theoretical propositions.
Chapter 3 Political accountability, incentives, and contractual design of public private partnerships: demand or availability risk?	Formalization of the choice between availability and concession contracts for the private provision of public services with an incomplete contract theory approach.		- Weaker accountability of public authorities when the private provider does not bear the demand risk. - Weaker accountability of private providers when they do not bear the demand risk. - Overall, a lower matching with consumers preferences over time under an availability contract than under a concession contract.

CHAPTHER 1

NUMBER OF BIDDERS, INFORMATION DISPERSION, RENEGOTIATION AND WINNER'S CURSE IN TOLL ROAD CONCESSIONS[1]

Infrastructure services, such as roads, bridges, highways, tunnels, often exhibit general public interest attributes, and sometimes, natural monopoly characteristics, that prevent their provision to be entirely left to private operators through a full privatization. Nevertheless, there has been an increasing interest to bring in private expertise into the production and provision of these goods and services. A well known economic rationale behind such an initiative for the public sector is to enhance productive efficiency of these goods and services.

Private participation in the provision of such services can globally be apprehended through the form of Public Private Partnerships (PPPs), which confer to the private partner a temporary right, regulated by the contract, to serve the market in question. Being a hybrid arrangement, PPPs might in fact dominate both fully public and private provisions by

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

inducing cost minimization behaviour by the private provider while reducing potential market failures by limiting the market power conferred on the private provider through the regulation by the contract. In other words, they may avoid substituting market failures with public failures.

An incontestable advantage to allowing private participation in the provision of public goods and services is also the possibility for the public authority to benefit from competitive pressures when choosing the private operator. As Vickers and Yarrow (1991) pointed out, "[c]ompetition […] can greatly improve monitoring possibilities, and hence incentives for productive efficiency […]", and that, "[…] it may be difficult to introduce rivalry without some private ownership […]".

A major source of competition may stem from auctions or competitive tendering procedures. Under such mechanisms, the State or a representative (local public authorities) awards an exclusive contract to the bidder offering the lowest price after an *ex ante* competition. In this case, competition during an auction *for* the market may substitute for the absence of competition *in* the market. The outcome of an auction can be enforced through a contract that the public authority establishes with the winning bidder. The latter is then left to provide the service in question, and is compensated according to the contractual terms based on her bid. This allows the public authority to reap the benefits of competition and avoid the inefficiencies of public provision. This idea has been developed as early as 1859 by Chadwick (1859), and has been popularized in later years by Demsetz (1968).

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.

However, the limits of these competitive procedures to attribute long-term public private contracts have been highlighted by the literatures. Goldberg (1976, 1977) and Williamson (1976), among others, pointed out that franchise bidding would provide an efficient framework if the only important aspect of the contracting process were to determine prices. When other contractual dimensions matter, franchise bidding may lead to an inefficient outcome (Yvrande 2006). In addition, the main economic literature emphasizes that the efficiency of this awarding procedure depends on the number of bidders. Nevertheless, the optimal number of bidders will depend on the exact structure of demand and information (Athey and Haile 2007).

Indeed, according to the Walrasian analogy of markets as auctions, an increase in the number of bidders should encourage more aggressive bidding, so that in the limit, as the number of bidders becomes arbitrarily large, the auction approaches the efficient outcome. But, while this may be true in private value auctions[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 in common-value auctions in which the competing bidders are differentially (but incompletely) informed about the value of the auctioned item. If bidders shared the same information, they would equally value the item of the auction[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 a trap and thus suffered unexpected low profit rates in the 1960's and 1970's on OCS lease sales "year after year"). Thus, bidding naively based on one's information would lead to negative expected profits, so that in equilibrium, a rational bidder internalizes the winner's curse by bidding less aggressively. Bidders must then bid more conservatively the more bidders there are, because winning implies a greater winner's curse. In other words, the greater the level of competition, the worse the news associated with winning in a common-value setting (Milgrom 1989, Bulow and Klemperer 2002, Hong and Shum 2002, Haile, Hong and Shum 2003, Hendricks, Pinkse and Porter 2003).

Thus, in common-value auctions, an increase in the number of bidders has two counteracting effects on equilibrium bidding behaviour. First, the increased competition leads to more aggressive bidding, as each potential bidder tries to maximize 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

[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).

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 rise – in the context of procurement auctions – as the number of competitors increases.

These considerations considerably matter in the context of PPPs. In fact, it is often advocated that the main problems associated with PPPs, as long-term contracts, are uncertainty, informational asymmetries, and renegotiation. However, we are aware of no empirical studies that test the prevalence and the magnitude of the bid effects of these features of PPPs. So far, there have been some empirical studies on the impact of the number of bidders on prices (Amaral, Saussier and Yvrande 2006, Gomez-Lobo and Szymanski 2001, Bulow and Klemperer 2002, Hong and Shum 2002) or on the impact of public information on bidding (De Silva, Dunne *et al.* 2005) in procurement contract auctions, but none in auctions for public private contracts. The auction theory offers an appropriate theoretical framework to test these effects, and hence to test whether uncertainty and renegotiation are *real* issues that one should consider when dealing with the efficiency of PPPs.

The objective of this chapter is therefore *to empirically explore the link between the number of bidders, information dispersion, and renegotiation on the one hand, and bidding behaviour on the other hand, in PPPs settings so as to be able to pin down the prevalence and importance of these features.*

To this end, we consider the particular case of toll road concession contract auctions (highways, roads, bridges, tunnels). We believe that these auctions provide a fertile ground to explore the issues raised above for several reasons. 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. As highlighted in the general introduction, the stakes involved in such auctions are large, since it has been recognised that infrastructure levels and quality significantly matter for economic growth and poverty alleviation. There are many empirical studies illustrating the impact of infrastructure on economic growth, among the more recent are Canning (1998), Calderon, Easterly and Serven (2003), Calderon and Serven (2002). These studies show that a 1 percent increase in the stock of infrastructure can increase GDP by up to 0.20 percent. Thus, there appears to be important efficiency and revenue lessons to be learned

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

from the results. In addition, these auctions are common-value auctions. In fact, uncertainty about future traffic – forecasting errors and associated risks are characteristics of infrastructure projects (Pickrell 1990, Flyvberg and Skamris 1997, Flyvberg, Skamris and Buhl 2002, Flyvberg, Bruzelius, Rothengatter 2003, Odeck 2004, Standard & Poor's 2004) –, the differing access to information about future states of the world across bidders, and their differing algorithms, lead to common values. Furthermore, within the set of such auctions, projects appear to differ significantly in the level of common uncertainty associated with traffic forecasts. There are two main factors that can reduce the level of contract valuation common uncertainty: the public release of information about future traffic, and the length of the facility. As the theory suggests that the effects of the winner's curse should be more apparent in auctions with a greater degree of common uncertainty (Milgrom and Weber 1982, theorem 16), these auctions permit the estimation of the importance of information dispersion relative to traffic uncertainty in these settings. Finally, but perhaps more interestingly, a particular characteristic of such auctions is that they are prone to a high incidence of renegotiation in less developed countries (Guasch, Laffont and Straub 2003 and 2005, Guasch 2004, Laffont 2005, Estache 2006), but also in developed countries (Gomez-Ibanez and Meyer 1993, Engel *et al.* 2003, 2005 and 2006, Athias-Saussier 2006). Imperfect enforcement leading to renegotiations is therefore a major characteristic of these contracts, which can strongly question the theoretical effects pointed out by the auction theory. More specifically, 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 forward looking bidder that the contract price may later be subject to profitable renegotiation. This fact affects bidding behaviour in subtle ways, and may strongly question the two theoretical effects highlighted above (Milgrom and Weber 1982).

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

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

The chapter is organized as follows. Section 1 presents the particular features of toll road concession auctions. To formalize the effects of an increase in competition on bidding behaviour in such auctions, we present in Section 2 a simple model of competitive bidding with common value components, and state our three theoretical propositions. Section 3 provides a description of the data while Section 4 reports the econometric results. In Section 5, we provide a robustness analysis of our results and Section 6 discusses the policy implications of our work and offers some concluding comments.

1. AUCTIONS FOR TOLL ROAD CONCESSIONS

1.1. First-Price, Sealed-Bid Auctions

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

Concession contracts are most often awarded in two stages; in the first stage, private consortiums submit their technical qualifications, following the rules defined by the public authority. In the second stage, qualified consortiums, *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.

1.2. Common Value Auctions

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

The degree of complexity and uncertainty comes directly to bear in the design of infrastructure concession contracts. Forecasting errors and associated risks are characteristics of infrastructure projects. Studies of such errors (Trujillo *et al.* 2002, Flyvbjerg *et al*. 2003, Flyvbjerg 2005, Standard & Poor's 2005) show that future traffic is largely overestimated, by large amounts. 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 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 forecasts. In fact, uncertainty in forecasts induces the possibility of manipulation that is exacerbated by the information asymmetries in concession projects.[5]

In addition, bidders have access in such an environment to different information. A bidder might conduct her own traffic forecast survey of a toll road concession or might learn about market conditions from her own customers and suppliers. Furthermore, even if bidders have access to the same market data, they may have different 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.* her 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 2007). In such

[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 the forecast itself determines whether the forecast is tested. In other words, this means that projects are not launched when the forecast is too low. 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 any inferences about the bidders' strategy (Nunez 2007).

cases it may be appropriate to model bidders as having different private information of a common values nature.

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

As a result, in toll road concession auctions, the winning bidder may be the one who most overestimate future traffic. This is all the more true that under first-price, sealed-bid auctions, bidders have less information on other bidders' estimates of project value.[6] Thus, there is a greater likelihood under sealed bidding that the winner's curse will occur - that the winning bidder is the unfortunate one who, out of ignorance, overestimates the value of what is being auctioned (Milgrom and Weber 1982, Klein 1998). Bidders who would fail to take this selection bias into account at the bidding stage would be subject to the winner's curse. How then should reasonably sophisticated bidders behave? A frequent piece of advice is: *bid cautiously*. Milgrom (1989) for example suggests that to make money in competitive bidding, you will need to mark up your bids twice: once to correct for the underestimation of costs – traffic overestimation in our case – on the projects you win, and a second time to include a margin for profits. Besides, since it is reasonable to expect the selection bias to increase when competition gets fiercer, he adds that the mark-up to adjust for underestimation – traffic overestimation – will have to be larger the larger is the number of your competitors.

1.3. 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 is studied in the experimental or empirical literature (Kagel and Levin 1986, De Silva *et al.* 2005). Such studies show that, in first-price, sealed bid auctions, public information reducing item valuation uncertainty can lead to more aggressive bidding behaviour[7] and that this effect can be more pronounced in auctions with larger common uncertainty.

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

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

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 sector

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

[8] This is also a way for us to check the robustness of the results obtained with the public release of information criterion, since the public release of information may affect the number of bidders (if bidders base their decision

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 interurban facilities than in short ones, misspecification or error prediction on some Origin-Destination pairs has less impact in equilibrium;
- short links are usually associated with dense networks where Wardrop equilibrium conditions (and existence) are complex (Boyce 2007);
- if the value of travel time saving increases with the travel length (as argued by many authors, e.g. Hensher 1976, Brett 1999, Hensher and Greene 2003, Hensher and Goodwin 2004), misspecification should occur for small savings because studies on stated and revealed value of travel time savings usually evaluate large time savings (Bureau of Transport Economics 1981, Button 1993);
- short distance travels do not follow the traditional relationship between GDP and mobility and are determined by life patterns. In particular, in urban transport, demand growth is strongly impacted by urban, land-use and transport policy (Schafer 2000).

1.4. Renegotiation in Toll Road Concessions

Infrastructure concession contracts are particularly prone to renegotiations. For instance, in a study on more than 1,000 concession contracts awarded during the 1990s in Latin America, Guasch (2004) found that 53% of the concessions in the transport sector were renegotiated, and this took place on average only 3.1 years after the signing of the contract.

Some renegotiation is desirable and is to be expected as contracts are in practice necessarily incomplete. Exogenous events that are not induced by either the government or the operator (like currency devaluation) can significantly affect the financial equilibrium of firms, and can be used as an opportunity to redistribute rents. However, the high incidence of renegotiations, particularly in early stages, appears to be beyond the expected or reasonable levels, and raises concerns (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.

---

to submit a bid on this type of information), implying that the coefficient of the *PUBLICINFO* variable interacted with the number of bidders may be biased.

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

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

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

2. BIDDING FOR TOLL ROAD CONCESSION AUCTIONS: A SIMPLE MODEL

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

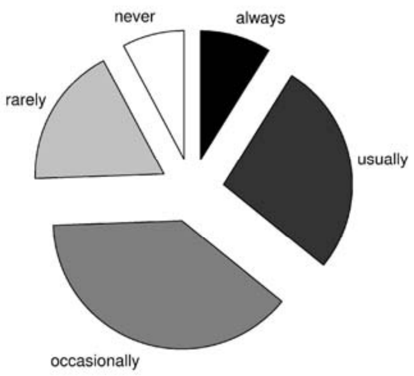
2.1. Model Framework

For concreteness, let assume that firms bid on lowest toll (this is not essential). We assume that there exists a one-to-one, decreasing, relation between the traffic forecast and the toll included in the bid. First, this boils down assuming that the costs (global investments and operation costs) are independently identically distributed – this assumption is made by numerous papers on PPP (e.g. Engel *et al.* 2007) –, and that costs underestimation cannot be used strategically – this seems realistic to the extent that concessionaires cannot complain *ex post* about cost underestimation since there are very few exogenous components in the cost estimation, and the uncertainty and information asymmetry between bidders and procuring authorities regarding construction costs are low. Second, this boils down also assuming that rates of return are the same across firms. Again, this does not seem to be a too restrictive assumption since it is well-known that procuring authorities expect a range of values for the financial rate of return of a particular project (most often between 8% and 12%).

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

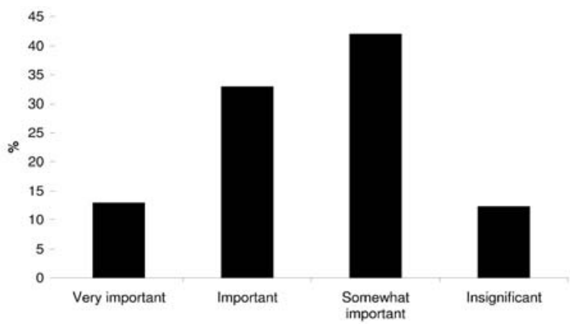
In addition, in a recent survey, Nunez (2007) asked a sample of 178 forecasters whether they were pressured to manipulate traffic forecasts. As highlighted by the following Figure 1.1, few forecasters (25,6%) declare that they are scarcely or never pressured about forecast results. Nunez (2007) also asked them about the role and sense of strategic manipulation of forecasts. Figure (1.2) shows that for around 46% of forecasters, the strategic manipulation of forecasts plays either a very important or an important role in the final traffic estimations. Other 42% consider that the strategic manipulation plays a somewhat important role. Only 12% of them judged this role insignificant (*i.e.* even though strategic manipulation exists, they do not affect the final estimations in a significant way). In addition, most forecasters affirm that this pressure plays in the sense of traffic overestimation. This result can be seen in Figure 1.3.

Figure 1.1: Frequency of pressure exercised on forecasters



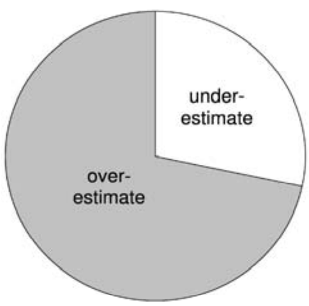
Source: Nunez (2007)

Figure 1.2: Importance of strategic manipulations in the final estimation



Source: Nunez (2007)

Figure 1.3: Sense of strategic manipulation



Source: Nunez (2007)

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

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

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

2.2. Model Setting

Let consider the actual traffic D_A. This actual traffic is determined by nature. Each firm receives an estimate of this actual traffic defined as $D_{EST} = D_A \pm \varepsilon$, where ε is i.i.d. with zero mean, so that bidders believe that the average of bidders' traffic forecasts is a good estimate of the actual traffic (a standard assumption in common-value models: see Bikhchandani and Riley 1991, Albers and Harstad 1991, Krishna and Morgan 1997, Klemperer 1998, Bulow and Klemperer 2002, and Goeree and Offerman 2003). In addition, we assume that rational bidders believe that the variance of ε is increasing in the number of bidders. In fact, if each bid is a random point in a certain probability distribution function, the variance of the sample will tend to increase concavely with the sample size – since each new independent observation (as in monte carlo experiment) has a certain probability to represent a more extreme value within this PDF – and then converge to the population's variance.

Each firm chooses then a strategic traffic forecast D_S such as $D_S = D_{EST} \pm s$. As highlighted in the previous section, the strategic bias s depends on the number of bidders, the

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

degree of common uncertainty, and the likelihood of renegotiation. So we have $s = f(Nb, CU, PR)$, where NB is the number of bidders, CU the level of common uncertainty, and PR the likelihood of renegotiation.

Given D_S, each firm chooses the toll $P = g(D_S)$ with $g' < 0, g'' < 0$. Again, as highlighted in the previous section, g is the same for each firm and given *ex ante*. We have then $P = g(D_{EST} \pm f(Nb, CU, PR))$.

The net present value can be written as

$$NPV = -\int_{t_0}^{t_e} I_t e^{-rt} dt + \int_{t_e}^{T} [P_t D_A(P_t) - C(D_A)] e^{-rt} dt \qquad (1)$$

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

We suppose that the demand is inelastic (with respect to both price and quality) and, as already discussed, that the main strategic variable is the demand, so that costs do not matter. Within this framework, only the gross benefit matters, which is $B = \int_{t_0}^{T} [P_t D_{A,t}] e^{-rt} dt$ (2)

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

$$P_{win} = P(D_i^S > D_j^S \forall j \neq i) \qquad (3)$$

2.3. Number of Bidders and Traffic Forecast Deviation

Let consider the forecast error e be the difference between the traffic forecast included in the bid and the actual traffic. So we have $e = s \pm \varepsilon$. The winner's forecast error can then be written as $e_i \middle| D_i^S > D_j^S \forall j \neq i = D_i^S - \frac{1}{N} \sum D_j^{EST}$ (4)

As the variance of ε is increasing in the number of bidders, then $e_i \middle| D_i^S > D_j^S \forall j \neq i$ is strictly increasing in the number of bidders: $e_i \middle| D_i^S > D_j^S \forall j \neq i = k(NB), k' > 0, k'' < 0$.

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

$P(D_i^S > D_j^S \forall j \neq i) = h(D_i^S, D_j^S \forall j \neq i, j = 1,..., NB-1)$ and

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

The expected forecast error is then $E(e_i) = k(NB) * h(D_i^S, D_j^S \forall j \neq i, j = 1,..., NB - 1)$

Since bidders are risk-neutral, they want the expected forecast error to be constant, let say equal to e_i^* . Thus, as the number of bidders increases, the probability of winning the bid has to decrease as much as the error term increases. Nevertheless, we assume that the impact of the increase in the number of bidders is weaker on the probability of winning than on the error term, *i.e.* the increase in the error term is not compensated by the decrease in the probability of winning. That is $-\frac{dh}{dNB} < \frac{dk}{dNB}$. This assumption seems realistic as we expect a high variance of traffic forecasts in our particular case due to the magnitude of traffic uncertainty. Thus, they have to decrease their traffic forecast to keep the expected forecast error constant. This is the winner's curse effect.

This leads to the following proposition:

Proposition 1: *The greater the number of bidders, the more likely bidders will be conservative to correct for traffic overestimation, i.e. the greater the effects of the winner's curse. So* $\frac{dD_i^S}{dNB} < 0$.

2.4. Number of Bidders and Level of Common Uncertainty

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

$$\frac{dD_i}{dCU} > 0 \tag{5}$$

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

$$e_i \Big| D_i^S > D_j^S \forall j \neq i = k(NB, CU), \frac{\partial k}{\partial NB} > 0, \frac{\partial k}{\partial CU} > 0, \frac{\partial k^2}{\partial^2 NB} < 0, \frac{\partial k^2}{\partial^2 CU} < 0$$

The expected forecast error is then

$$E(e_i) = k(NB, CU) * h(D_i^S, D_j^S \forall j \neq i, j = 1,..., NB - 1) \tag{6}$$

Equations (5) and (6) indicate that an increase in the common uncertainty may have two counteracting effects on bids. First, since the variance increases with the common uncertainty, the winning bid is an increasing function of the common uncertainty (Equation (5)). Second, to keep the expected error constant, bidders should review their bids – forecasts – downwards

(Equation (6)). As a result, the winning bid may increase or decrease with the common uncertainty, depending on which of these two effects prevails.

Furthermore, repeating the same exercise as previously, we obtain that the higher the common uncertainty, the more bidders will internalise the winner's curse as the number of bidders increases, *i.e.* $\frac{\partial}{\partial CU}\frac{\partial D_i^S}{\partial NB} < 0$.

This leads to the following proposition:

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

2.5. Number of Bidders and Renegotiation

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

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

$$E^R(e_i) \in [E(e_i), \overline{e_i}^{PR}] \text{ with } \overline{e_i}^{PR} = E(e_i)\frac{1}{1-PR} \qquad (7)$$

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

$$\overline{e_i}^{PR} = k(NB, CU)h(D_i^S, D_j^S \forall j \neq i, j = 1,..., NB-1)$$

Then, as the probability of renegotiation increases, an increase of the number of bidders has a weaker impact on the correction of traffic forecast overestimation, that is $\frac{\partial}{\partial PR}\frac{\partial D_i^S}{\partial NB} > 0$.

This leads to the following proposition:

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

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

3. DATA ON ROAD CONCESSION CONTRACT AUCTIONS

We have constructed a unique dataset consisting of 49 toll road concession contract auctions (highways, bridges and tunnels). As illustrated by the Table 1.1, projects in the sample are fairly evenly distributed across countries. They are from Australia, Brazil, Canada, Chile, France, Germany, Hungary, Israel, Jamaica, Portugal, South Africa, Thailand, and United Kingdom. The oldest auctions in the sample were awarded in 1989, whereas the latest was in 2003. Most of data included in the database was provided by concessionaires and by regulators. Some others come from scientific and professional press. So far, the database that we self-constructed is the most exhaustive one on toll road concession auctions.

Table 1.1: Toll Road Concessions by Country and by Year

	Year															
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[10]										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**

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

3.1. Dependent Variable: Traffic Forecast Deviation

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

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

$$TFD = \frac{1}{n} \sum_{t=t_0}^{t_0+n-1} \frac{forecast_t}{actual_t} \qquad (8)$$

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

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

Figure (a) in Appendix 1.1 gives the distribution of this *TFD* variable in the sample[11]. One aspect of this contractual record draws immediate attention: the prevalence of traffic overestimation, as highlighted by the existing literature (e.g. Flyvberg and Skamris 1997, Estache 2001), since the average deviation is 1.25, *i.e.* an average overestimation of 25%.

[11] For confidentiality reasons, we are not allowed to show the distribution of the traffic forecast deviation by country.

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 1.1 presents the distribution of the number of bidders in our sample. Most auctions have between 2 and 4 bidders.[12] Table 1.2 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. Thus, we include in our regressions the dummy variable *PUBLICINFO* and the variable *LENGTH*, reflecting the length of the facility in kilometres. The prediction is that each of these variables, interacted with the number of bidders, will have a positive impact on the traffic forecast deviation.

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

[12] 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.

concession contracts – absence of a regulator in most countries, all price-cap contracts, and consortiums composed most of time of both local and foreign companies – we introduced three variables to capture the reliability of contract enforcement. The first one, the variable *GOVLEARN*, reflects the experience of the procuring authority in awarding concession contracts. As a large number of prior concessions should decrease the probability of renegotiation (Guasch, 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 enforcement mechanism than poorer ones. In other words, the government's "tolerance for renegotiation" depends on the investment in enforcement. This is the reason why we expect stronger institutional framework in wealthier countries and hence a lower probability of contractual renegotiation in such countries. The hypothesis is therefore that greater numbers of bidders for projects taking place in wealthier countries will more likely lead to more conservative bidding behaviour at equilibrium than in poorer ones, *i.e.* to a negative impact of the crossed variable *HIC*NUMBER OF BIDDERS* on our *TFD* dependent variable (highlighting a greater winner's curse effect in wealthier countries).

However, as discussed above, we also observe renegotiations in developed countries, even if it is at a lower incidence. The legal system may then serve as a useful guide for the probability of enforcing the agreed upon contract. There has been increased attention from economists and legal scholars directed to the question of what legal environments best promote economic growth and stability. Some have suggested that common law regimes outperform civil code regimes throughout the world (La Porta *et al.* 1998 and 1999). More specifically, institutional features that traditionally characterize a common law regime make it more difficult to renegotiate under such a legal regime than under a civil law system. The reason is that in civil law countries, legislation is seen as the primary source of law. By default, courts thus base their judgments on the provisions of codes and statutes, from which solutions in particular cases are to be derived. Courts have therefore to reason extensively on the basis of general rules and principles of the code, often drawing analogies from statutory provisions to fill lacunae and to achieve coherence. By contrast, in the common law system, cases are the primary source of law, while statutes are only seen as incursions into the common law and thus interpreted narrowly.

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

The variables used in our estimations are summarized in the following Table 1.2 and their respective distribution, as well as the correlation matrix, are respectively given in Appendices 1.1 and 1.2.

Table 1.2: 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

4. ECONOMETRIC RESULTS

In order to test our three theoretical predictions, we have performed log-log regressions[13] (so as to be able to interpret the results in terms of elasticity) using OLS and Maximum Likelihood Estimation methods. Ten models were estimated. We first analyse the overall impact of the number of bidders on bidding behaviour (Model 1). We then examine the effects of the winner's curse on contract auctions with differing levels of common-value components (Models 2 to 6). Finally, we identify, in Models 7 to 10, if the theoretical effects still hold when we account for the possibility for bidders to renegotiate the contract.[14] Results are reported in Tables 1.3 and 1.4.

[13] Only the dummy variables are not taken as logarithms in the model.

[14] 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 1.3: OLS Estimation Results

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
number of bidders (NB)	-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)	-0.711*** (-2.72)	-0.863*** (-2.94)	-0.873*** (-3.17)
Publicinf*NB		0,110* (1,92)			0,127** (2,43)					
Publicinf*Govlearn*NB			0,039* (1,90)			0,041** (2,14)				
Length				-O,182** (-2,36)	-0,201*** (-2,73)	-0,170** (-2,28)	-0,198** (-2,58)	-0.238*** (-3.23)	-0.207*** (-2.71)	-0.257*** (-3.48)
Length*NB				0,103* (1,68)	0,117* (1,98)	0,089+ (1,50)	0,119* (1,93)	0.134** (2.31)	0.113* (1.88)	0.144** (2.48)
Govlearn*NB							-0,014+ (-1,49)			-0.004 (-0.36)
HIC*NB								-0.159** (-2.93)		-0.138** (-2.16)
Civillaw*NB									0.131* (1.82)	0.117* (1.71)
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)	1.453*** (4.33)	1.381*** (3.90)	1.570*** (4.62)
R2	0,149	0,212	0,210	0,299	0,382	0,365	0,333	0,414	0,348	0,452
Adjusted R2	0,131	0,178	0,176	0,252	0,326	0,308	0,272	0,360	0,289	0,373
N	49	49	49	49	49	49	49	49	49	49

*Significance levels: +0,15 * 0,10 ** 0,05 *** 0,01*
t-stat are in parentheses.

Table 1.4: Maximum Likelihood Estimation Results

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
number of bidders (NB)	-0.220*** (-2.94)	-0.257*** (-3.09)	-0.261*** (-3.27)	-0.678*** (-2.89)	-0.779*** (-3.10)	-0.659*** (-3.11)	-0.682*** (-2.52)	-0.711*** (-3.17)	-0.862*** (-3.51)	-0.873*** (-3.12)
Publicinf*NB		0.110+ (1.58)			0.127** (2.02)					
Publicinf*Govlearn*NB			0.039+ (1.56)			0.041+ (1.59)				
Length				-0.182*** (-2.72)	-0.200*** (-2.93)	-0.169*** (-2.76)	-0.198*** (-2.89)	-0.238*** (-4.08)	-0.207*** (-3.08)	-0.257*** (-3.83)
Length*NB				0.103*** (1.81)	0.116* (1.89)	0.089+ (1.61)	0.119** (1.97)	0.134*** (2.62)	0.113** (2.03)	0.143** (2.39)
Govlearn*NB							-0.013 (-1.13)			-0.004 (-0.26)
HIC*NB								-0.159** (-2.28)		-0.138+ (-1.60)
Civillaw*NB									0.131** (1.87)	0.117* (1.74)
Constant	0.452*** (5.22)	0.435*** (5.05)	0.474*** (5.70)	1.229*** (4.59)	1.291*** (4.53)	1.193*** (4.99)	1.266*** (4.42)	1.453*** (5.91)	1.381*** (4.95)	1.570*** (5.14)
R2	0.149	0.212	0.210	0.299	0.382	0.365	0.333	0.414	0.348	0.452
Adjusted R2	0.131	0.178	0.176	0.252	0.326	0.307	0.272	0.360	0.289	0.373
N	49	49	49	49	49	49	49	49	49	49

*Significance levels: +0,15 * 0,10 ** 0,05 *** 0,01*
t-stat are in parentheses.

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 of both estimation methods 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 (they find that 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).

We also observe that this winner's curse effect is even larger for projects for which the common uncertainty is greater. In fact, the public release of information prior to bidding, regarding the procuring authority's internal forecast of the future traffic, has a positive impact on the traffic forecast deviation variable when interacted with the number of bidders. This result suggests, consistent with the theory, that one way to hinder the winner's curse effects is to reduce the information dispersion on the contract valuation by giving more contract information. This highlights the bid effects of uncertainty over the value of a contract, which has been largely ignored.[15] 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 implies that a weaker degree of common uncertainty leads to a forecast error reduction that more than compensates for the increase in the aggressive bidding behaviour (*i.e.* the effect captured by Equation (5) is stronger than the one captured by Equation (6)), the length variable interacted with the number of bidders has a positive and significant impact (1% significance level with the Maximum Likelihood Estimation method)

[15] We also observe that the direct impact of the release of the procuring authority's own traffic forecast on the *TFD* variable is negative (the coefficient is -0.284) but not significant. We did not introduce the direct effect of *PUBLICINFO* in our regressions because it is highly correlated with the interacted variable *PUBLICINFO*NB BIDDERS*. For this same reason, we did not introduce the direct effects of the interacted dummy variables *HIC*, *CIVILLAW* and *GOVLEARN*.

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.

Results of Models 7 to 10 show that the effects of the winner's curse are significantly higher when bidders expect a lower likelihood of renegotiation. In particular, as predicted, Model 7 indicates that the effect of the variable *GOVLEARN* interacted with the number of bidders is negative, though almost not significant, on the *TFD* variable. This may corroborate the result of Guasch (2004) of a negative impact of the experience of the public authority on the probability of renegotiation. In addition, 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 are consistent with our proposition 3 and suggest that the effect of the winner's curse depends on the likelihood of renegotiation, and hence stress the necessity of improving 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. Moreover, toll road concession contracts are long-term contracts and Chong (2007) shows that collusion is hardly sustainable when contracts are long-term contracts. Thus, it seems uncertain that bid rigging and collusion may occur in such auctions. In addition, even if some bid rigging or collusion exists, it tends to mitigate the winner's curse effect. Yet, we still find statistical evidence of the winner's curse effect.

Much of the empirical work on auctions faces the problem of an endogenous number of bidders. The auction bidders who chose to bid may have been attracted by some aspect of the contract being auctioned that is not captured in the other regressors or is unobservable to the econometrician. If this aspect is correlated with traffic forecast deviation, then we need to instrument for the number of bidders. Nevertheless, employing potentially weak instruments may not yield more accurate estimates. In addition, 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 Tables 1.5 and 1.6, we introduce additional variables, not explicitly theoretically considered, that could potentially affect the traffic forecast deviation and alter the significance of our core variables. These are reputation effects, the duration of contract, the total construction costs, the political ideology of the public procuring authority and a trend variable.

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

The *DURATION* variable, defined as the number of months between the completion of the infrastructure construction and the end of the concession, captures the increasing uncertainty associated with long time horizons in forecasting future traffic growth. The hypothesis is that longer concession period increases uncertainty, leading to greater traffic growth forecast errors.

The amount of investments – measured in terms of total construction costs – may affect the importance candidates will give to the production of a better traffic forecast and also the bidders' determination to win the auction.

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

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

Table 1.5: OLS Estimation Results with Control Variables

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
number of bidders (NB)	-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)	-0.711*** (-2.72)	-0.863*** (-2.94)	-0.873*** (-3.17)	-0,979*** (-3,45)	-1,016*** (-3 ,42)
Publicinf*NB		0,110* (1,92)			0,127** (2,43)							
Publicinf*Govlearn*NB			0,039* (1,90)			0,041** (2,14)						
Length				-O,182** (-2,36)	-0,201*** (-2,73)	-0,170** (-2,28)	-0,198** (-2,58)	-0.238*** (-3.23)	-0.207*** (-2.71)	-0.257*** (-3.48)	-0,289*** (-3,77)	-0,307*** (-3,82)
Length*NB				0,103* (1,68)	0,117* (1,98)	0,089+ (1,50)	0,119* (1,93)	0.134** (2.31)	0.113* (1.88)	0.144** (2.48)	0,161*** (2,74)	0,168** (2,72)
Govlearn*NB							-0,014+ (-1,49)			-0.004 (-0.36)	0,006 (0,51)	0,005 (0,36)
HIC*NB								-0.159** (-2.93)		-0.138** (-2.16)	-0,148** (-2,32)	-0,143* (-1,72)
Civillaw*NB									0.131* (1.82)	0.117* (1.71)	0,104+ (1,52)	0 ,116+ (1,48)
Repeated											-0,132+ (-1,47)	-0,138+ (-1,49)
Investment												0,010 (0,25)
Duration												-0,070 (-0,56)
Left												-0,057 (-0,68)
Trend												-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)	1.453*** (4.33)	1.381*** (3.90)	1.570*** (4.62)	1,767*** (4,83)	2,457*** (2,99)
R2	0,149	0,212	0,210	0,299	0,382	0,365	0,333	0,414	0,348	0,452	0,476	0,499
Adjusted R2	0,131	0,178	0,176	0,252	0,326	0,308	0,272	0,360	0,289	0,373	0,386	0,351
N	49	49	49	49	49	49	49	49	49	49	49	49

*Significance levels: +0,15 * 0,10 ** 0,05 *** 0,01*
t-stat are in parentheses.

Table 1.6: Maximum Likelihood Estimation Results with Control Variables

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
number of bidders (NB)	-0.220*** (-2.94)	-0.257*** (-3.09)	-0.261*** (-3.27)	-0.678*** (-2.89)	-0.779*** (-3.10)	-0.659*** (-3.11)	-0.682*** (-2.52)	-0.711*** (-3.17)	-0.862*** (-3.51)	-0.873*** (-3.12)	-0.979*** (-3.41)	-1.015*** (-3.35)
Publicinf*NB		0.110+ (1.58)			0.127** (2.02)							
Publicinf*Govlearn*NB			0.039+ (1.56)			0.041+ (1.59)						
Length				-0.182*** (-2.72)	-0.200*** (-2.93)	-0.169*** (-2.76)	-0.198*** (-2.89)	-0.238*** (-4.08)	-0.207*** (-3.08)	-0.257*** (-3.83)	-0.289*** (-4.19)	-0.307*** (-4.05)
Length*NB				0.103*** (1.81)	0.116* (1.89)	0.089+ (1.61)	0.119** (1.97)	0.134*** (2.62)	0.113** (2.03)	0.143** (2.39)	0.161*** (2.59)	0.167*** (2.55)
Govlearn*NB							-0.013 (-1.13)			-0.004 (-0.26)	0.006 (0.42)	0.005 (0.24)
HIC*NB								-0.159** (-2.28)		-0.138+ (-1.60)	-0.148* (-1.76)	-0.143+ (-1.48)
Civillaw*NB									0.131** (1.87)	0.117* (1.74)	0.104+ (1.51)	0.116+ (1.50)
Repeated											-0.132+ (-1.55)	-0.137 (-1.40)
Investment												0.010 (0.20)
Duration												-0.069 (-0.41)
Left												-0.056 (-0.66)
Trend												-0.110 (-1.29)
Constant	0.452*** (5.22)	0.435*** (5.05)	0.474*** (5.70)	1.229*** (4.59)	1.291*** (4.53)	1.193*** (4.99)	1.266*** (4.42)	1.453*** (5.91)	1.381*** (4.95)	1.570*** (5.14)	1.767*** (5.56)	2.456*** (2.57)
R2	0.149	0.212	0.210	0.299	0.382	0.365	0.333	0.414	0.348	0.452	0.476	0.499
Adjusted R2	0.131	0.178	0.176	0.252	0.326	0.307	0.272	0.360	0.289	0.373	0.386	0.351
N	49	49	49	49	49	49	49	49	49	49	49	49

*Significance levels: +0,15 * 0,10 ** 0,05 *** 0,01*
t-stat are in parentheses.

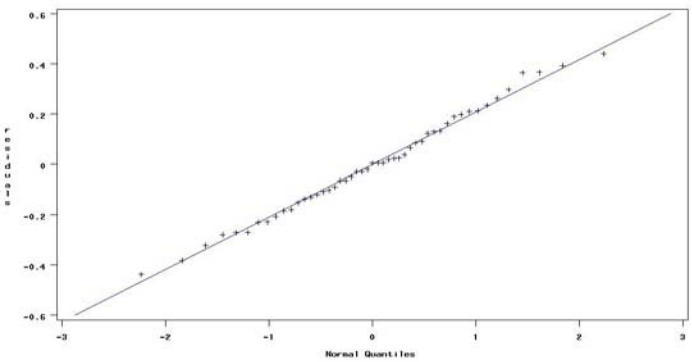
Model 11 of both estimation methods indicates that the results remain unaltered when controlling for dynamic considerations. In fact, while the variable *REPEATED* is weakly significant (15% significance level) and has a negative effect on the TFD – suggesting that reputational effect might play a role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

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

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

Finally, to test the robustness of our results, it is also possible to perform some tests on the normality of the residuals. The line of Henry is one possibility to test the normality of the residuals. It connects the actual values of the residuals (Y axis) with values z built under the assumption that the distribution of the residuals is normal. Ideally, one must have the identity, *i.e.* all the points of the graph located on the line. Here, the result is rather satisfactory, although a very light skew appears with the extreme values.

Figure 1.4: Line of Henry



The Shapiro-Wilk test (Shapiro and Wilk 1965) tests the null hypothesis that a sample came from a normally distributed population. In the Shapiro-Wilk test for normality, the p-value is based on the assumption that the distribution is normal. In our case, the p-value is extremely large (0.93) indicating that we cannot reject that residuals are normally distributed.

6. CONCLUSION

In recent years, there has been an increasing political demand to get the private sector involved in the building and operation for the provision of public services. One of the goals that underpin this trend is greater productive efficiency: private operators are widely perceived to be more efficient than their public counterparts. For such services, a way to benefit from private expertise is to use a PPP to form a partnership with a private operator. Indeed, full privatization of these services is often politically hard to achieve due to their inherent general public interest attributes.

However, as literatures point out, the inherent contractual incompletenesses of PPPs – mainly due to the uncertainty associated with these long-term contracts – lead to the need of *ex post* renegotiation so as to adapt the contract to contingencies, leaving room for potential opportunistic behaviour from both the private provider and the public authority. Uncertainty and renegotiation are therefore the two main issues associated with PPPs.

This chapter has proposed to test the prevalence and importance of such issues, which has never been done before to our knowledge. In particular, an important advantage in using PPP resides in the fact that public authorities may use an auction mechanism to attribute this PPP to a private provider. Competitive pressures generated during the process may well substitute for the absence of market forces in the market that so often characterizes public services. However, in presence of uncertainty and informational asymmetries, auction theory shows that a fiercer competition can lead to less aggressive bidding behaviour, because bidders internalize the winner's curse. Thus, one way to pin down the prevalence and the magnitude of uncertainty, informational asymmetries and dispersion, and renegotiation in PPPs settings is to look at the bidding behaviour of private providers.

In this chapter, we have conducted such an analysis in the particular case of toll road concession auctions, which seems highly relevant for the purpose of this analysis. To this end, we collected original data on the difference between the actual traffic and the traffic forecast included in the winning bids, for 49 worldwide toll road concession contracts. To further examine the potential effects of information dispersion and renegotiation, we self-collected data on projects' and contracting parties' characteristics, on the public policy regarding the release of traffic forecasts prior to bidding, and on institutional and legal frameworks.

We show that the winner's curse effect is particularly strong in toll road concession contract auctions. More precisely, we show, with a high level of significance, 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. Finally, 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. Thus, we highlight the bid effects of uncertainty, information dispersion and renegotiation over the value of a contract, which has been largely ignored, and more specifically we show that uncertainty and renegotiation are *real important* issues to consider when one tackles the efficiency of PPPs.

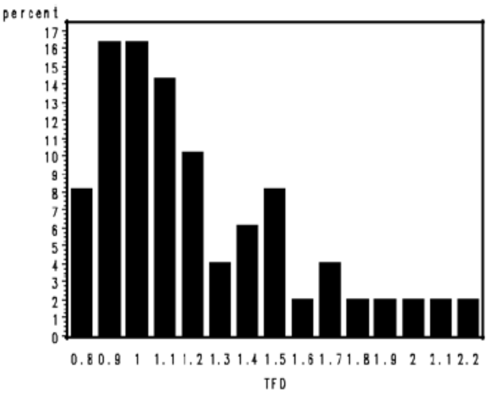
The policy implication of our results is not straightforward. In fact, while we show that asymmetric information overturns the common economic wisdom that more competition is always desirable, since we find a strong winner's curse effect in toll road concession auctions, we also show that there is a systematic traffic overestimation due to methodological and behavioural sources, which implies that in most cases bidders will experience *ex post* very low or negative profit rates if they do not renegotiate the contractual terms. Thus, the short-term policy implication of our results would fit the standard view: governments should restrict entry, or favour negotiations over auctions (Bulow *et al.* 1999), in toll road concession auctions to favour aggressive bidding. By contrast, the long-term policy implication of our results is that governments may wish to maintain the procedure as open as possible to the extent that the winner's curse effect reduces the systematic traffic overestimation and then reduces the likelihood that the procuring authority will have to renegotiate the contract, once eventual bidding competitors are gone. In other words, the policy implications of our results depend on public authorities' myopia.

In addition, we find that bidders less internalize the winner's curse when procuring authorities release their own traffic forecast prior to bidding. Thus, myopic procuring authorities, hence interested in reducing the winner's curse effect, should consider releasing contract information that may reduce information dispersion in these toll road auction settings. The opposite would apply for non myopic public authorities.

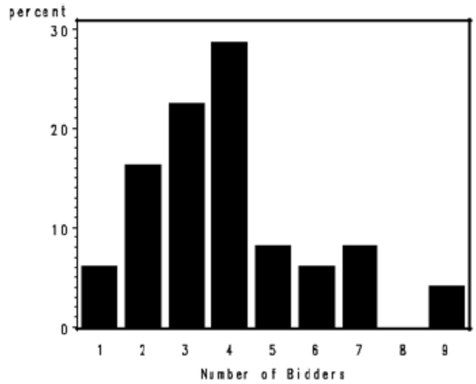
It seems important to further investigate this study so as to take into account dynamic concerns. Indeed, even in a stationary environment, dynamic considerations arise if firms engage in collusion. Even though, as discussed, the occurrence of collusion is not obvious in toll road concession auctions, it might be worth considering it. Moreover, the underlying distribution of valuations might change as a function of auction outcomes, potentially in ways that are observable (or can be directly inferred) by the other bidders. For example, bidders may have capacity constraints (or more general forms of diseconomies of scale). In that case, a bidder that wins an auction today might draw a valuation from a less favourable distribution in the future.

More generally, these results point out the necessity to improve on 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. As we have seen, at the *ex post* stage, renegotiation mechanism may affect bidding behaviour at the *ex ante* stage, and should therefore be taken into consideration. In other words, our results highlight 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.

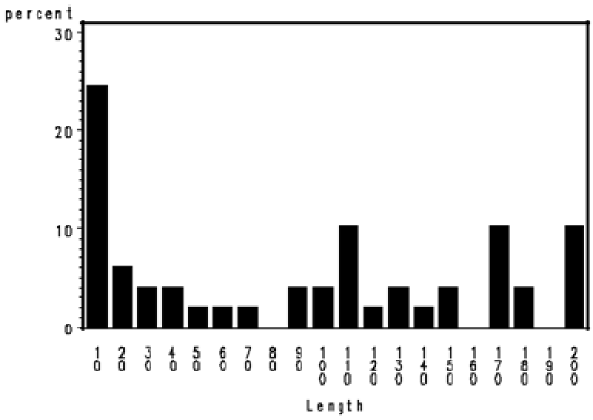
Appendix 1.1: Histograms for the regression variables



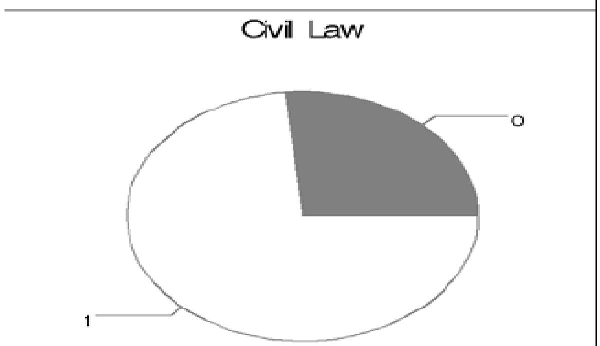
(a) Traffic Forecast Deviation



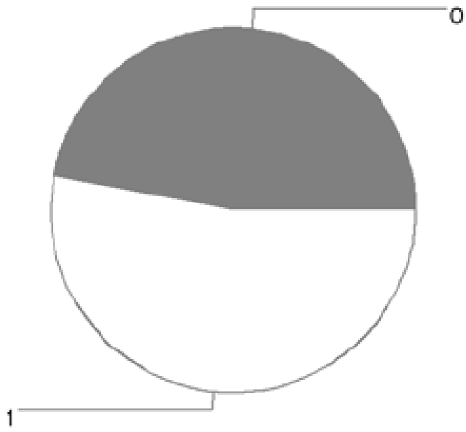
(b) number of bidders



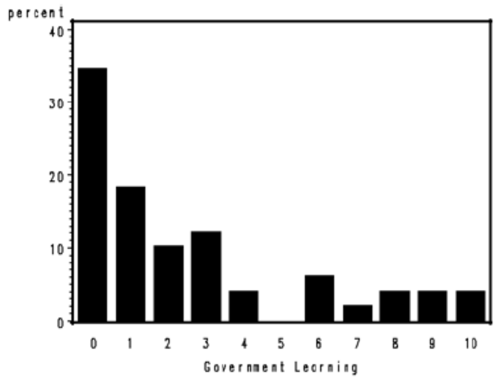
(c) length (km)



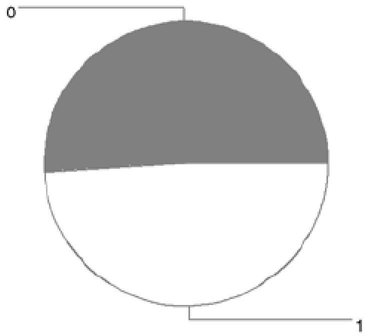
(d) Civil Law Countries



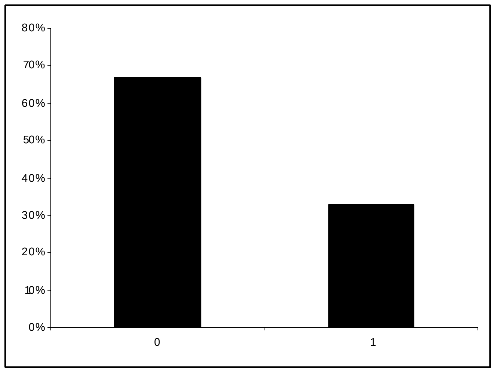
(e) HIC



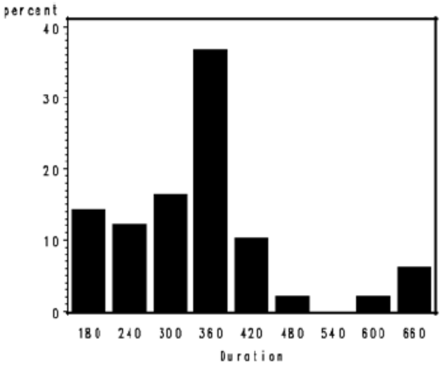
(f) government learning



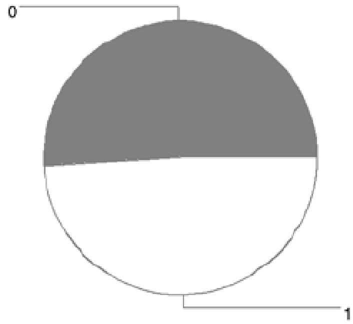
(g) Plubic Release of Traffic Forecast



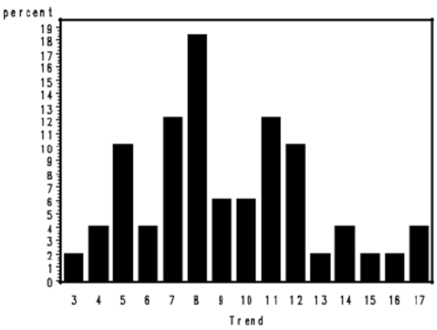
(h) repeated contract



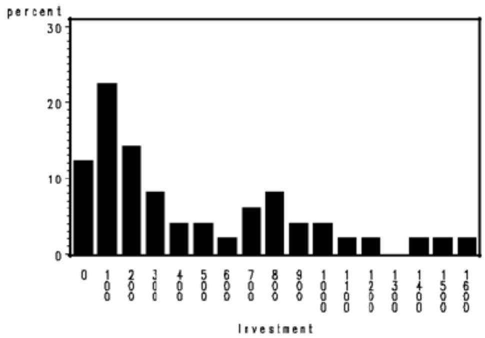
(i) Contract Duration (months)



(j) LEFT



(k) Trend Variable



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

Appendix 1.2: 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

CHAPTER 2

CONTRACTUAL FLEXIBILITY OR RIGIDITY FOR PUBLIC PRIVATE PARTNERSHIPS?

THEORY AND EVIDENCE FROM INFRASTRUCTURE CONCESSION CONTRACTS [1]

Due to natural monopolistic dimension and general public interest attributes inherent to infrastructures services, a way for public authorities to benefit from private expertise is to resort to Public Private Partnerships (PPPs). Being a hybrid arrangement, PPPs might in fact dominate both fully public and private provisions by inducing cost minimization behaviour by the private provider in charge of the provision while reducing potential market failures by limiting the market power conferred on the private provider *via* the regulation through the contract. The fact is that in the last couple of decades, PPPs have become increasingly popular in many countries, and a variety of administrative arrangements have been used (see Grout and Stevens 2003).

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[1] A short version of this chapter was published in *Revue Economique*, vol. 58, N°3, May 2007, pp. 565-576.
This chapter is based on a joint work with Stéphane Saussier.
We gratefully acknowledge comments and suggestions from Claude Abraham, David Azéma, Mathias Dewatripont, Gianni de Fraja, Guido Friebel, Eduardo Engel, Antonio Estache, Alexander Galetovic, Pierre Garrouste, Paul Grout, Elizabetta Iossa, Etienne Lehmann, Claude Ménard, Vincent Piron, Mar Rubio, Annalisa Vinella, Dean Williamson and participants at the conference on Public Services and Management organized by the IDEI centre, University of Toulouse (2006), the 9th ISNIE Conference, Barcelona (2005), the 4th Conference on Applied Infrastructure Research organized by the WIP centre, Berlin University of Technology (2006), the ATOM & ADIS seminars in Paris (2006), the Bristol CEPR conference on Public-Private Partnerships (2006), the Kiel CEPR public policy symposium (2006), the 21st annual congress of the European Economic Association, Vienna (2006) and the 5th IIOC annual conference, Savannah (2007).

Nevertheless, even in the UK where there is significant resort to PPPs, still 85% of public investment is delivered through conventional forms of procurement (HM Treasury 2003). At the same time, there is a bad feedback on experience in Latin American countries (Guasch 2004, Estache 2006), but also in developed countries (Gomez-Ibanez and Meyer 1993, Engel *et al.* 2006). As we have emphasized in the previous chapter, uncertainty, informational asymmetries and renegotiation are important issues associated with PPPs, and might explain this mixed context. It is therefore crucial to consider potential solutions to these issues. One way to tackle these issues is to adapt the contractual design of such contracts accordingly. Another way is to not impose the demand risk on the private provider, but this solution will be considered in the third chapter.

In this second chapter, *we aim to highlight the tradeoffs at stake between contractual flexibility and rigidity for PPPs*. We develop a model in which private providers incentives to innovate and adapt the public-service provision depends on the contractual design. A private provider that receives less of the benefits generated by its specific investments in the research of possible innovations (*i.e.* there is a hold-up by the public authority) will have weaker incentives, which causes inefficient development over time of the private public-service provision. One way to reduce these inefficiencies is for the contracting parties to write an *ex ante* contract that pins down all the possible contingencies so as to avoid any renegotiation and hence ensure the private provider not to be expropriated *ex post* from a part of the surplus generated by its investments in the research of possible innovations. The drawback of such a contract is that it does not allow the contracting parties to adjust the contract to sates of the world, whereas, as already emphasized, PPPs are characterized by a high uncertainty. An optimal contract trades off these two effects. Our model explains why the contracting parties can write not only rigid contracts in order to avoid renegotiations but also flexible contracts in order to adapt contractual framework to unanticipated contingencies.

To motivate our work, it is useful to relate it to the literature on incomplete contracts (Hart 1995). A typical model in the context of PPPs in that literature goes as follows. A public authority and a private provider meet initially. Since the future is hard to anticipate, they write an incomplete contract. As time passes and uncertainty is resolved, the parties can and do renegotiate their contract, in a Nash-bargaining fashion, to generate an *ex post* efficient provision. However, as a consequence of this renegotiation, each party shares some of the benefits of prior (noncontractible) relationship-specific investments with the other party.

Recognizing this, each party underinvests *ex ante*. So far, the literature has studied how the allocation of asset ownership and formal control rights can reduce this underinvestment.

The originality of our approach resides in the fact that we show that the contractual design can also affect the incentives to invest in relationship-specific investments[2], and we mix incomplete contract theory and transaction cost theory. More precisely, we propose an incomplete contract theory model *with* renegotiation and maladaptation costs, permitting us to study alternative contract forms in a refined incomplete contract framework. In addition, we argue that it is crucial to introduce in the analysis a particular characteristic of such public private contracts, namely the potential for renegotiation even if toll adjustment provisions are completely rigid and well designed. This problem has been highlighted in the first chapter of this dissertation, through the bidding behaviour of private providers. We have in fact shown that bidders for PPPs anticipate in their bids future profitable negotiations that highly depend on institutional and legal frameworks. This finding is largely corroborated by studies in less developed countries (Guasch 2004, Laffont 2005, Guasch, Laffont and Straub 2006) and also in developed countries (Gomez-Ibanez and Meyer 1993, Engel *et al.* 2006, Martimort and Straub 2006). Renegotiation is thus seen, in our model, more like a political decision than a way to avoid maladaptation costs of a rigid contract. We therefore consider the likelihood of contractual renegotiation as an independent dimension, not connected to the design of the contract that is signed. This is a way for us to insist on the fact that a more rigid contract is not a more complete (optimal) contract and thus a contract that is less probably renegotiated (Saussier 2000). This is in stark contrast to previous empirical studies on this topic, which consider that rigidity and completeness are synonyms, both reflecting a lower probability of renegotiation (Crocker and Masten 1991, Crocker and Reynolds 1993, Bajari and Tadelis 2001).

We then empirically test the predictions of our model by focusing on *how* parties adjust prices – tolls – in toll road concession contracts (highways, bridges, tunnels). Again, 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. We can find in these contracts a Toll Adjustment Provision (TAP), which consists in determining *ex ante* the tolls that can be charged to users *ex post*. While there have been some empirical studies of how the contracting parties choose

[2] Incomplete contract theory (a la Grossman and Hart), despite its name, is actually a theory of ownership rather than contracting (except for the very recent article of Hart and Moore 2007). In restricting feasible contract forms, incomplete contract theory assumes what a theory of contracting seeks to explain (Masten-Saussier 2002).

among alternative pricing processes in private commercial contracts or in procurement contracts (Crocker and Masten 1991, Crocker and Reynolds 1993, Bajari and Tadelis 2001), there has been, to our knowledge, no such analysis in toll infrastructure concession contracts. As already highlighted, these contracts are special in numerous ways – they are very long-term contracts (often over 30 years) involving a degree of uncertainty and hence a likelihood of renegotiation that are much greater than in most ordinary contracts – and should deserve a special attention. To this end, we constructed an original database consisting of 71 worldwide toll road concession contracts.

We show, in contrast with many papers that often assume the rigidity of such contractual relationships, that this rigidity seems to be the exception rather than the rule regarding toll adjustment provisions. Indeed, we observe in our sample a great variety of toll adjustment provisions, from very rigid ones such as firm-fixed price provision in which tolls are fixed for the whole length of the concession, to very flexible ones with the so-called renegotiation provisions, which consist in determining *ex ante* periodic *ex post* negotiations of the toll adjustment provision initially chosen.

We complement the data on the design of toll adjustment provisions with data gathered from contracts and other sources that describe the type of concessionaires, the traffic uncertainty and the complexity surrounding each project, the number of bidders, the country institutional framework, the experience of the public authority, the number of repeated interactions between the concessionaire and the public authority, political leanings, and so forth.

Our main empirical findings can be summarized as follows. First, the results indicate a strong negative correlation between traffic uncertainty and the rigidity of the toll adjustment provision actually chosen, so that contracts for which traffic uncertainty is high are more likely to be flexible. Second, our data also reveals a substantial variation in contract design across contracting parties' characteristics. For instance, when the public authority and the concessionaire have contracted repeatedly before, contracts are more likely to be flexible. The presumption is that both had behaved reliably so that they both now have a better reputation with the other. This is consistent with previous empirical studies that document the effect of reputation on the choice of contracts (Crocker and Reynolds 1993, Banerjee and Duflo 2000) and with many recent studies (Bajari, McMillan and Tadelis 2003, Doni 2006, Schugart 2005) that insist on the fact that reputation particularly matters in PPPs. In addition, we also find strong evidence of political effects. Contracts signed with left leaning public authorities, rather than with right leaning public authorities, appear to be more likely rigid. This seems to corroborate the conjecture that private concessionaires have a better reputation among right wing public authorities. Finally, we find strong evidence that the institutional framework impacts on the rigidity of the toll adjustment provision chosen. In particular, our measure of the reliability of contract enforcement negatively correlates with the rigidity of the contract, so that stronger institutional frameworks will more likely lead to flexible contracts.

The chapter is organized as follows. We begin in Section 1 with a discussion on the economic tradeoffs involved in designing public private contracts. We then propose in Section 2 a model of these tradeoffs leading to propositions that are to be tested. Section 3 describes the empirical implications of the model. In Section 4, we describe the contractual toll adjustment processes observed in our sample of contracts and in Section 5, we present the original data used in the empirical section. Section 6 contains the econometric results, and section 7 proposes a robustness analysis of our results. A final section provides concluding remarks.

1. ECONOMIC TRADEOFFS IN CONTRACT DESIGN OF PUBLIC PRIVATE CONTRACTS

Public private partnerships framework fits well the literature on incomplete contracts (Hart 1995). Indeed, the imperfect verifiability of the services in public private contracts has been largely emphasized.[3] We are thinking, for example, of how difficult it can be to demonstrate (and sanction) that amendments to the terms are required by the concessionaire's inability, rather than by unexpected external factors. Furthermore, the public authority often does not sue a concessionaire for partial non-fulfillment of obligations, because litigation can require very long times and produce uncertain results, while it surely worsens the relationship with the counter-party. Lastly, the risks discharged on the contracting party cannot be unlimited. For this reason, the extent of the penalties cannot always be proportioned to the damage caused by imperfect fulfillment.

[3] In the literature, a contractual aspect is called perfectly verifiable when 1/ a third party can verify the case occurred in relation to this aspect; 2/ the cost of litigation that falls upon the Principal is not greater than the benefit which it can obtain from a sentence in its favour; 3/ the extent of the penalties is not subject to any limitation. When one of these three requisites is not satisfied, there is a risk of not being able to obtain the full enforcement of the contract (Doni 2005).

Such characteristics of the transaction impede the crafting of complete contracts (Hart 1995). The non-verifiable investments may result in higher surplus or better service quality delivered by the private operator. We focus on concession contracts in which the private operator has residual control rights over the way the service is provided. We suppose that, after the initial contract has been agreed, the provider may underinvest or come up with innovative ways of providing the service. Since such innovations could not be foreseen when the initial contract was designed, bargaining may take place over the splitting of the surplus from implementation of the innovations. The private operator's anticipation of the outcome of such bargaining affects its incentive to research possible innovations, and its anticipation will depend on the contractual design (flexible or rigid).

The framework proposed by the incomplete contract theory seems therefore to fit well with public-private contracts. However the incomplete contract theory narrowed the focus on one type of transaction cost – the hold-up problem. Thus, in this theoretical framework *ex post* bargaining is always efficient. This chapter pays also attention to two different kinds of transaction cost: maladaptation costs due to misalignment of the contract with states of nature, and renegotiation costs, namely haggling and friction due to *ex post* changes and adaptations when contracts are incomplete. This focus is motivated by a careful examination of public private contracts (Gomez-Ibanez and Meyer 1993, Bajari *et al.* 2004, Guasch 2004, Estache 2006) and by the results obtained in the first chapter.

Moreover, as noted above, in contrast to the previous literature on this topic (Crocker and Masten 1991, Crocker and Reynolds 1993, Bajari and Tadelis 2001), we assume that renegotiation costs are not a function of the contractual design. In other words, we believe that a contract in which contracting parties aim at covering *ex ante* most contingencies that may arise *ex post* is not always less renegotiated than a contract in which contracting parties do not have this goal.

2. THE MODEL

2.1. Structure of the Model

We consider two contracting parties. One is the State or a representative (local public authorities). The other is a private operator. The contract is such that essentially the private party supports investments. This is coherent with what we observe in many PPPs. This is also what is considered by Hart (2003) as a specificity of such relationships.

A part of the investments performed by the private investors is non-verifiable (but not necessarily specific). Thus we make the assumption that it would be impossible or too costly for the State or a third party to check investments made by the private operator. We note these investments *i*. They generate a surplus noted *R(i)*.[4] We make the classical assumptions that $R'>0$, $R''<0$ and $R'''<0$.

To realize the transaction, the parties may sign two kinds of incomplete contracts:

- On the one hand a rigid contract, in which the contracting parties are trying to specify the way to coordinate according to future states of nature. In other words, in such a contract, the parties try to prevent renegotiation, essentially by deciding the price that will be charged by the private operator for the whole length of the contract.
- On the other hand a flexible contract, in which parties do not try to avoid renegotiation and plan to renegotiate price once uncertainty unfolds.

We note $f \in \left]0,1\right]$, where $\underline{f}$ $(\overline{f})$ represents the impact on the *ex post* surplus of a rigid (flexible) contract. Thus we make the assumption that the *ex post* realized surplus of the transaction is a function not only of the investments but also of the adequacy of the contract to states of nature. f measures this adequacy level. A rigid contract generates maladaptation costs (*i.e.* a realized surplus for the private operator $\underline{f}R(i) \leq R(i)$). A flexible contract generates renegotiation costs (*i.e.* a realized surplus $\overline{f}R(i) \leq R(i)$ to be shared between the contracting parties).

We note *r(i)* the value of the outside option of the private operator in the case of an *ex post* contract breach. We make the assumption that $r(i) = \alpha \cdot R(i)$ with α the level of investment specificity. When α → 0 then investments made by the private operator do not generate any surplus when used outside of the contractual relationship. Investments are therefore totally specific to the relationship.

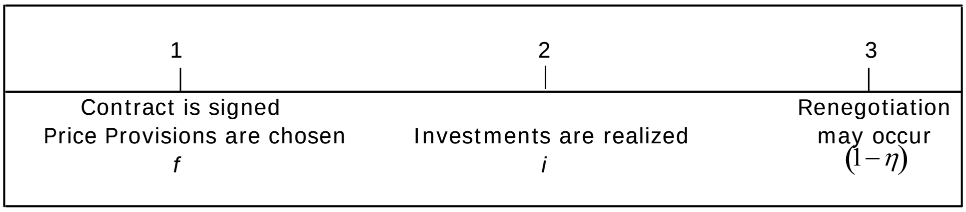
Finally, as already explained, we consider the likelihood of contract renegotiation exogenous and we note (1- η) the probability to see a rigid contract be renegotiated. This is another dimension of our model reflecting the specificity of public private partnerships. More precisely, the contracting parties are often in an asymmetric position and such contracts are

[4] Without loss of generality, we normalize the size of contractible and verifiable investment to zero. The investment *i* must therefore be understood as any additional "efficiency investment", which we assume is non-verifiable although observable by both parties (See Schmidt 1996 for similar arguments).

often linked to political decisions so that such arrangements might be renegotiated independently of what has been initially decided in the contracts (Guasch 2004; Laffont 2005).

The timing of the model is standard.

Figure 2.1. Timing of the Model



2.2. Investment Levels and Contract Design

First Best

As a benchmark, it is useful to specify the first-best solution, which would obtain if investments were verifiable. Contracting parties would then choose investment level in a way to maximize the total economic surplus *S* generated by the contractual relationship given by

$$S = Bo - Co + R(i^*) - i^* \qquad (1)$$

where *Bo* and *Co* are positive constants and respectively the social benefit and cost of providing the basic service without any investment.

Thus, the optimal level of investment is i^* such that

$$i^* \,|\, R'(i^*) = 1 \qquad (2)$$

Flexible Contracting

When parties decide to sign a flexible contract, they accept the fact that they will have to renegotiate after investments have been made. Since the private operator is now entrenched as the provider, its bargaining power is not eroded by competition from other potential operators (given that it provides the service at, at least, the basic level specified in the initial contract). We therefore assume that the private operator and public authority (the government G) have equal bargaining powers and hence consider a renegotiation where the surplus generated by the non verifiable investments, *R(i)*, is shared between the parties through a Nash-bargaining solution.[5]

[5] Thus, following Hart-Shleifer-Vishny (1997), we assume that the public authority does not maximize the global surplus during renegotiations: its utility function is given by the welfare of the rest of society, excluding the

Private operator's objective function is profit π_c, where[6]

$$\pi_c = P_0 - C_0 + \frac{1}{2}\left[\overline{f}R(i) + r(i)\right] - i \tag{3}$$

where *Po* is the payment that the private operator would obtain if service provision were to be at its basic level. He chooses a level of investment i^f such as

$$i^f \Big| R'(i^f) = \frac{2}{\left(\overline{f} + \alpha\right)} \tag{4}$$

When the parties sign a flexible contract, the first best is not attainable, at the exception of a particular case where $\overline{f} = 1$ (*i.e.* there are no renegotiation costs) and $\alpha = 1$ (*i.e.* there are no specific investments). Surplus generated by such a contract is sub-optimal because of the low incentives for the operator to invest since he anticipates that he will have to let a part of the surplus generated by his investments to the State when renegotiation occurs ($i^f \leq i^*$).

Consumer surplus is then given by CS^f, where

$$CS_f = B_0 - P_0 + \frac{1}{2}\left[\overline{f}R\left(i^f\right) - r\left(i^f\right)\right] \tag{5}$$

The social surplus S^f, which is the sum of consumer surplus and the profit of the private operator is:

$$S^f = B_0 - C_0 + \overline{f}R(i^f) - i^f \tag{6}$$

Rigid Contracting and Parties Can Commit not to Renegotiate

When the contracting parties devise a rigid agreement and pledge that they will not renegotiate then the profit of the private operator is given by:

$$\pi_c = P_0 - C_0 + \underline{f}R(i) - i \tag{7}$$

The private operator only receives a part of the surplus generated by its investments, which depends whether the contract matches states of nature. He chooses a level of investment i^r such that

---

private operator. A justification for this is that the political process aligns the public authority's and society's interests (since the private operator has negligible voting power, his interests receive negligible weight). Of course, if the government placed the same weight on the private operator's utility as on the rest of society, the first-best could be achieved.

[6] The way the surplus is shared is nevertheless impacted by the outside options of each party.

$$i^r \Big| R'(i^r) = \frac{1}{\underline{f}} \tag{8}$$

Consumer surplus is then given by CS^r, where

$$CS^r = B_0 - P_0 + \left(1 - \underline{f}\right) R(i^r) \tag{9}$$

The *ex post* maladaptation of the contract results in the recovery by the consumers of a part of the surplus generated by the private operator's investments. This simply means that if the private operator thinks of investments in order to improve quality or other dimensions of the provided service, he anticipates that, because renegotiation is not an option, he will retain only a part of the generated surplus, depending on whether the initial agreement matches with states of nature. The other part is considered as a positive externality for consumers.

The total surplus is then given by S^r, with

$$S^r = B_0 - C_0 + R\left(i^r\right) - i^r \tag{10}$$

It can be noticed that, for a given level of investment, a flexible contract leads to a lower total surplus than a not renegotiated rigid contract. This is due to the fact that a flexible contract, in contrast to a rigid one, induces renegotiation costs that constitute deadweight losses. However, this does not imply that rigid contracts are always to be preferred to flexible ones since the global surplus is also a function of the investments realized by private operators. More precisely, under rigid contracting, private operators might underinvest for fear of contractual maladaptation, leading to a lower surplus compared to the flexible contracting case. This will be analyzed later.

Rigid Contracting and Parties Cannot Commit not to Renegotiate

Nevertheless, as discussed above, when parties sign a rigid contract, there is always a risk that this contract will not be applied *ex post* and will be renegotiated – thus leading to the case of an initial flexible agreement. Then, if we consider that a rigid contract might be renegotiated, the profit generated by such contract for the private contractor is given by

$$\pi_c = \eta\left[P_0 - C_0 + \underline{f}.R(i) - i\right] + (1-\eta)\left[P_0 - C_0 + \frac{1}{2}\left[\overline{f}.R(i) + r(i)\right] - i\right] \tag{11}$$

where (1-η) is the probability to see the *ex ante* rigid contract be renegotiated. The optimal level of investment is then given by

$$i^{rr} \mid R'(i^{rr}) = \frac{2}{\alpha + \overline{f} + \eta(2\underline{f} - \alpha - \overline{f})} \tag{12}$$

We observe that when $\eta = 1$ (*i.e.* the probability to renegotiate a rigid contract is zero), we find the results that would occur when the government can credibly commit not to renegotiate (equations 8 and 12 are the same).

Consumer surplus is then given by

$$CS^{rr} = \eta\left[B_0 - P_0 + (1-\underline{f})R(i^{rr})\right] + (1-\eta)\left[B_0 - P_0 + \frac{1}{2}\left[\overline{f}.R(i^{rr}) - r(i^{rr})\right]\right] \tag{13}$$

It follows that the total surplus is

$$S^{rr} = B_0 - C_0 + (1-\eta)\overline{f}R(i^{rr}) + \eta R(i^{rr}) - i^{rr} \tag{14}$$

2.3. Comparisons

As already discussed, we do not consider the case of rigid contracting without any renegotiation as a plausible one. Thus, we will always compare and contrast flexible and renegotiated rigid contracts.

Contractual Choices and Global Surplus

To be able to generate propositions about efficient contractual choices, and thus to be able to rank rigid and flexible contracting, we have to compare the generated total surplus under the two types of contracting.

More precisely, a rigid contract – but renegotiated with a probability $(1-\eta)$ – will be preferred to a flexible one when

$$S^{rr} > S^{f} \Leftrightarrow B_0 - Co + \overline{f}R(i^f) - i^f < B_0 - Co + (1-\eta)\overline{f}R(i^{rr}) + \eta R(i^{rr}) - i^{rr} \tag{15}$$

Which leads to the following condition

$$\overline{f}R(i^f) - i^f \prec \overline{f}R(i^{rr}) - i^{rr} + \eta \underbrace{\left[R(i^{rr})(1-\overline{f})\right]}_{\substack{loss \quad of \quad surplus \\ due \quad to \quad renegotiation}} \tag{16}$$

Because both investment levels i^{rr} and i^f are increasing in $\overline{f}$ but at different rates, it is not straightforward to find out clear-cut propositions focusing on surplus comparison (*i.e.* a change in the level of $\overline{f}$ has a direct impact and an indirect impact through investment levels).[7] This is also true for the other parameters in our model. The partial derivatives in order to disentangle direct effect and indirect effects (*i.e.* through investment levels) of each of our parameters are presented in Appendix 2.0. They lead us to the following propositions.

PROPOSITION 1. (1) Suppose $\overline{f} \succ \alpha$.

Then, the higher the maladaptation costs (*i.e.* the lower $\underline{f}$), the more efficient a flexible contract compared to a rigid one.

Proof. (See Appendix 2.0)

The assumption $\overline{f} > \alpha$ is, in our case, a realistic assumption. Investments made in road infrastructures, because they are non removable, are completely specific to the relationship (*i.e.* $\alpha \to 0$). Furthermore, such contracts signed between private operators and the State, when they lead to renegotiation, are characterized by conflicts and renegotiation costs (*i.e.* $\overline{f} \succ\succ 0$).

Proposition 1 is intuitive. Signing a flexible contract is a way to avoid maladaptation costs. The higher the maladaptation costs, the more interesting it is to avoid them through a flexible contract.

Other trade-offs highlighted by our derivatives depend crucially on the investment level considered under each contractual form.

PROPOSITION 2. (1) Suppose $\overline{f} > \alpha$

(2) Suppose $\eta \succ 0$

(3) $i^{rr} \succ i^{f} \Leftrightarrow \left(2\underline{f} - \overline{f}\right) \succ \alpha \Rightarrow \underline{f} \succ \dfrac{\overline{f} + \alpha}{2}$.

Then, the higher the probability to renegotiate a rigid contract, the more efficient a flexible contract compared to a rigid one.

PROPOSITION 3. (1) Suppose $\overline{f} > \alpha$

(2) Suppose $\eta \succ 0$

(3) $i^{rr} \succ i^{f} \Leftrightarrow \left(2\underline{f} - \overline{f}\right) \succ \alpha \Rightarrow \underline{f} \succ \dfrac{\overline{f} + \alpha}{2}$.

[7] It is one striking difference between our model and standard incomplete contract models, in which renegotiation under symmetric information ensures that all organization choices yield an *ex post* efficient outcome (*i.e.* the only difference between the organizational choices concerns the choice of *ex ante* investment levels). This is not the case in our framework because we postulated renegotiation costs.

Then, the higher the level of asset specificity (*i.e.* the lower α), the less efficient a flexible contract compared to a rigid one.

Proof. (See Appendix 2.0)

Condition (3) constrains maladaptation costs to be bounded compared to renegotiation costs. This is likely to be the case in our contracts since they include guarantees for the private operator in cases maladaptation costs are too high (like guarantees against *force majeure* risks).

Proposition 2 highlights the fact that rigid contracts might be useful only as long as contracting parties believe that it has a fairly good probability to be enforced. In fact, there is no point in signing a rigid contract if one knows that it will be renegotiated.

Proposition 3 stresses the fact that rigid contracts, by defining *ex ante* the way the surplus (generated by the investments made by the operator) is to be shared, might secure the operator.

<u>PROPOSITION 4.</u> (1) Suppose $\overline{f} > \alpha$

(2) Suppose $\eta \succ \dfrac{R(i^{rr}) - R(i^{f})}{R(i^{rr})}$

(3) Suppose $i^{rr} \succ i^{f} \Leftrightarrow \left(2\underline{f} - \overline{f}\right) \succ \alpha \Rightarrow \underline{f} \succ \dfrac{\overline{f} + \alpha}{2}$.

Then, the lower the renegotiation costs, the more efficient a flexible contract compared to a rigid one.

Proof. (See Appendix 2.0)

Proposition 4 is intuitive. As soon as you consider the case when maladaptation costs are bounded compared to renegotiation costs (condition (1)), then the lower the renegotiation costs, the more efficient a flexible contract compared to a rigid one only if the probability not to renegotiate a rigid contract is high enough (condition (2)). If the probability to renegotiate the contract was nearly one, then there is no advantage of using flexible contracts compared to rigid one, because rigid and flexible contracts become similar devices.

Those propositions are intuitive. Nevertheless, we would like to point out the fact that they differ from previous incomplete contract theory models. As we already noticed, previous works using an incomplete contract framework focused on the make or buy issue, opening the way for critics saying that the incomplete contract theory is only a property right theory and has nothing to say about alternative contractual choices. Furthermore, our results highlight the fact that tradeoffs are complex and do not correspond to previous propositions coming from a transaction cost framework (Crocker and Masten 1991; Crocker and Reynolds 1993). More precisely, those previous works argue that a rigid contract is to be preferred as soon as specific assets are high. We highlight the fact that this proposition may be true, but only if other conditions concerning maladaptation costs, renegotiation costs and the probability to see the contract enforced are met. Lastly, our results stress the fact that the institutional environment in which the contract is embedded matters. In fact, the probability to see the contract enforced is clearly part of this institutional framework.

3. RELATING THE MODEL TO DATA

Our model points out the costs and benefits of two types of contractual design. In this section, we describe the empirical implications of this model.

Our model yields one elementary prediction about how contractual choices will differ across institutional frameworks. As highlighted before, we assume that the likelihood of unanticipated renegotiation is exogenous, *i.e.* disconnected from the contractual design. Renegotiation is thus considered, in our model, as a political decision. The probability of renegotiation is therefore correlated with the institutional and regulatory environment in which the contract takes place. To the extent that it is useless to devise a rigid contract if one knows that it will be renegotiated, a first prediction is therefore that weak institutional frameworks (e.g. the reliability of contract enforcement is weak) will more likely lead to flexible contracts.

Our model also yields two predictions about how the contractual design will differ across project characteristics. First, the theory suggests that contracting parties are less likely to design rigid contracts for which the uncertainty is higher (proposition 2). The intuition is that maladaptation costs are a function of uncertainty, so that the higher the uncertainty, the higher the probability that the rigid contract will be badly specified. Second, following directly from proposition 3, the theory predicts that contracting parties are more likely to devise rigid contracts for which the degree of investment specificity is high.

A further set of predictions that emerges from the theoretical framework concerns the magnitude of the renegotiation costs. The model suggests that the higher the renegotiation costs, the more likely contracts will be rigid. The straightforward empirical implications of this proposition involve differences in contracting parties' characteristics as well as differences in institutional environments. In fact, on the one hand, costs of *ex post* adaptation are a function of the willingness of the contracting parties to enter or not in conflicts, haggling and friction. Thus, when parties decide to devise a flexible contract, they have to account with whom they sign the contract, as renegotiation will inevitably occur. Reputation is therefore an important dimension, reducing the probability of high *ex post* renegotiation costs. To this extent, it is possible that differences in political ideology (e.g. left or right leaning public authorities) might affect contractual choices. On the other hand, the institutional framework might also impact on the contracting parties opportunism to the extent that it impacts on the probability of success of an opportunistic behavior. Thus, weak institutional frameworks, in which the probability of success of an opportunistic behavior is high, imply the possibility of important renegotiation costs and then will more likely lead to rigid contracts. The overall impact of the institutional environment on the contractual rigidity is therefore ambiguous (it has a positive impact through η but a negative one through $\overline{f}$)

To test our propositions, we now turn to the case of toll adjustment provisions in infrastructure concession contracts.

4. TOLL ADJUSTMENT PROCESSES IN INFRASTRUCTURE CONCESSION CONTRACTS

4.1. The Particular Case of Infrastructure Concessions

As highlighted by the first chapter, the degree of complexity and uncertainty and the likelihood of opportunism come directly to bear in the design of infrastructure concession contracts.

The design of contractual compensation processes in infrastructure concession contracts is not regulated, *i.e.* there are no rules that determine the set of allowable toll adjustment processes. This is another particular feature of infrastructure concession contracts and this complete freedom in determining the contractual compensation arrangement explains their great diversity and complexity, highlighted in the next part. This strengthens the relevance of the analysis of the choice of the toll adjustment process.

Finally, as already highlighted in the first chapter, concession contracts are most often awarded under an open bidding procedure, usually in two stages. Then, once the best offer is selected, there is the so-called "preferred bidder phase", during which the public authority negotiates with the preferred bidder the final terms of the contract. Thus, during this phase, the public authority and the private operator, through negotiation, have the opportunity to make the contract more rigid or more flexible. Although this preferred bidder phase is nowadays questioned because of transparency problems, leading to more and more adhesion contracts, all the contracts of our database are concerned by this phase. This feature of the award process of toll infrastructure concessions introduces reputational considerations in the choice of contractual terms, making the study of such a choice even more interesting.

4.2. Toll Adjustment Types

The toll adjustment processes that we have found in our sample, which we now address in detail, are summarized in the following Table 1.1. Toll – or price – adjustment processes can be divided into two categories, automatic processes and renegotiation processes, except for the most stringent possibility, the "firm-fixed price" contract (FFP), in which price is specified to be independent of future events. The FFP contracts are however very scarce in infrastructure concessions because of their high uncertainty, as discussed above.

Automatic Adjustment Processes

Automatic provisions adjust tolls periodically according to predefined formula. The most extreme, rigid form of this category is a definite escalator (DE) that adjusts tolls according to an explicit, predefined schedule, increasing tolls at a stipulated rate, for example. While the toll that applies at a particular date is easily determined by reference to the contract, definite escalators have the obvious disadvantage of failing to make use of information arising over the course of the relationship and thus suffer many of the deficiencies of firm-fixed price contracts. Parties have then devised DE contracts that provide more flexibility, by allowing the concessionaire a predefined margin around the adjusted price (DE/MARG). Still, even these contracts may miss cost or demand changes specific to a particular transaction and thus adjust tolls imperfectly. On the other hand, contracting parties are ensured of the sharing of the surplus.

In contrast, fixed-price with economic price adjustment (EPA) contracts attempt to relate contract tolls to market conditions as they unfold. The process of compensation is formulaic and the equation ties toll to market data such as the consumer price index or specific labor or materials indices. In practice, the flexibility of such a contract depends upon the number and importance of the indexed categories. This is the reason why we have distinguished the fixed-price with partial economic price adjustment contract, which uses the consumer price index to determine tolls according to an agreed-upon compensation formula (FP/CPI), from the fixed-price with economic price adjustment contract, which uses cost indices (FP/COST). Implementation remains thus straightforward, while tolls become more flexible. But the requirement that the contingencies and the compensation formulas must be explicitly prespecified constrains the flexibility of such contracts. Besides, the practicality of indexing is limited by the relationship-specific nature of many of the assets developed that isolates the parties from market alternatives. The possibility for the concessionaire to be ensured of a fixed minimum increase of the fixed-price through a definite escalator (FP/EPA/DE), or to have a predefined margin around the adjusted price (FP/EPA/MARG), or a traffic variation indexation (FP/EPA/TRAFFIC) in the compensation formula, even if it provides more flexibility, does not remove these drawbacks.

Parties have also devised adjustment provisions such as not-to-exceed price (NTEP) clauses, which afford more flexibility while constraining seller opportunism. The not-to-exceed price (NTEP) has been specified initially and the concessionaire has to negotiate with the public authority the determination of a firm price at or below the ceiling. Thus, NTEP contracts are not pure automatic adjustment processes insofar as the final price is the result of a negotiation but they are also not renegotiation provisions inasmuch as the contracting parties do not specify *ex ante* periodic negotiation of the toll adjustment process. In addition, in all the contracts resorting to this NTEP adjustment, the toll ceiling is loosened by indexing those tolls to the consumer price index (NTEP/CPI) or to prespecified cost indices (NTEP/COST). This approach entails less prespecification than FP/CPI or FP/COST, as contingencies that may influence the final toll are not enumerated. Nevertheless, the not-to-exceed-price specified initially may turn out to be unsuitable (due to forecasting errors on construction costs or traffic). Thus, to protect concessionaires from unsuitable compensation adjustment, parties have devised not-to-exceed-price with economic price adjustment contracts – CPI or COST or both – that either ensure the concessionaire a fixed minimum increase of the NTEP through a definite escalator (NTEP/DE/EPA), or an indexation to traffic variation (NTEP/TRAFFIC/EPA), or a margin of prices (NTEP/EPA/MARG). Still, even these contracts do not totally protect the concessionaire from an unsuitable ceiling toll. In addition, the need to check and validate traffic variation makes the provisions with indexation to traffic variation more costly to implement than mere index formulas and, being less definite, introduce a somewhat greater prospect of strategic behavior. The most flexible option, as an automatic adjustment process, affords the concessionaire total freedom in determining and imposing tolls during ten years and then establishes a NTEP with indexation to cost indices adjustment for the rest of the concession (FREE/NTEP/COST).

Renegotiation Adjustment Processes

Parties have also devised in our sample of contracts renegotiation provisions (RENEG), which consist in determining *ex ante* periodic *ex post* negotiations of the initial adjustment process. Thus, periodically, parties take into account the full range of relevant information before reaching agreement on toll. These provisions afford therefore the transaction a considerable degree of flexibility. Nevertheless, the parties may structure the negotiation process by, for example, defining in the contract the sequence of offers and acceptances or specifying the defaults if agreement cannot be reached. The advantage of renegotiation adjustment processes is obvious. They permit the parties to take full advantage of current information in adjusting tolls. Hence, they provide a high degree of flexibility. But they also expose the parties to the costs of having to negotiate mutually acceptable terms. Under these arrangements, there is a considerable scope for exercising subtle bargaining strategies.

The following table summarizes toll adjustment process. The first eight price adjustment processes are rigid enough to work without any external intervention. They clearly are rigid toll adjustments, accepting maladaptation costs in order to avoid *ex post* renegociation. The last seven price adjustment processes explicitly open the room for *ex post* negotiation as the final price is the result of a negotiation between the private operator and the public authority.

4.3. Toll Adjustment Types and Contractual Rigidity

The description of the toll adjustment processes found out in our sample of contracts, points out that contracting parties do not determine future prices with the same degree of rigidity (Table 2.1). As already discussed, the choice between the various adjustment types will reflect the relative costs of governing relationships under the respective arrangements. On the one hand, renegotiation provisions generally offer wider latitude to respond to changing conditions but subject the parties to the need to negotiate prices on a regular basis. On the other hand, automatic adjustment processes avoid the expense of negotiations but are less sensitive to relationship-specific events.

Table 2.1: Toll Adjustment Types

Type	Negotiated *Ex Ante*	Negotiated *Ex Post*
Firm-fixed price (FFP)	Price	No negotiation ex post
Definite escalator (DE)	Price , escalator	Only adjustment to price according to an explicit predefined schedule
Definite escalator with a margin (DE/MARG)	Price , escalator, margin	Only adjustment to price according to an explicit predefined schedule with the flexibility afforded by a predefined margin
Fixed price with partial economic price adjustment (FP/CPI)	Price, Economic price adjustment formula based on the consumer price index	Only formulaic adjustment to price as specified ex ante
Fixed price with economic price adjustment (FP/COST)	Price, Economic price adjustment formula based on specific labor or materials indices	Only formulaic adjustment to price as specified ex ante
Fixed price with EPA and with a definite escalator (FP/EPA/DE)	Price, Economic price adjustment formula, definite escalator	Only formulaic adjustment to price as specified ex ante and according to an explicit predefined schedule
Fixed price with EPA and with a margin (FP/EPA/MARG)	Price, Economic price adjustment formula, margin	Only formulaic adjustment to price as specified ex ante with the flexibility afforded by a predefined margin
Fixed price with EPA and with traffic variation indexation (FP/EPA/TRAFFIC)	Price, Economic price adjustment formula, traffic indexation	Only formulaic adjustment to price as specified ex ante and to traffic variation
Not-to-exceed price with partial economic price adjustment (NTEP/CPI)	Ceiling price, Economic price adjustment formula based on the consumer price index	A firm price at or below the ceiling
Not-to-exceed price with economic price adjustment (NTEP/COST)	Ceiling price, Economic price adjustment formula based on specific labor or materials indices	A firm price at or below the ceiling
Not-to-exceed price with a definite escalator and an economic price adjustment (NTEP/DE/EPA)	Ceiling price, definite escalator, Economic price adjustment formula	A firm price at or below the ceiling
Not-to-exceed price with a traffic variation indexation and an economic price adjustment (NTEP/TRAFFIC/EPA)	Ceiling price, Traffic variation indexation, Economic price adjustment formula	A firm price at or below the ceiling
Not-to-exceed price with economic price adjustment and with a margin (NTEP/EPA/MARG)	Ceiling price, Economic price adjustment formula, Margin	A firm price at or below the ceiling
Freedom during ten years and then NTEP/COST (FREE/NTEP/COST)	Ceiling price, Economic price adjustment formula based on specific labor or materials indices	A firm price at or below the ceiling after ten years
Renegotiation Adjustments (RENEG)	Initial automatic adjustment process, Frequency of renegotiation	A firm price

As a consequence, we may rank the contract types encountered in infrastructure concessions according to a qualitative index of rigidity. The following tables 2.2 and 2.3 indicate the ranking of price adjustment processes that are used in the empirical part, where lower numerical values correspond to less rigid contracts[8]. The most specific contract in this regard is clearly the FFP, which permits no toll adjustment at all. When escalated by a definite adjustment or by an economic price adjustment tied to the consumer price index or the realized costs of important inputs, the contract is less rigid, yet more rigid than NTEP contracts, and their different variations, which afford the concessionaire more flexibility in determining tolls according to the actual context, but also substantial scope for opportunism. Nevertheless, the upper bound restrains the most opportunistic redistributive strategies, in contrast to renegotiation adjustments, which however permit the parties to take full advantage of current information.

Table 2.2: Dependent Variable Used in the Ordered Logit Estimations (11 groups)

	Frequency	Mean
TYPE = 1 if RENEG	3	6,28
= 2 if FREE/NTEP/COST	10	
= 3 if NTEP/EPA/MARG	10	
= 4 if NTEP/TRAFFIC/EPA	3	
= 5 if NTEP/DE/EPA	3	
= 6 if NTEP/COST or NTEP/CPI	4	
= 7 if FP/EPA/MARG	10	
= 8 if FP/EPA/TRAFFIC	2	
= 9 if FP/EPA/DE	12	
= 10 if FP/COST or FP/CPI	6	
= 11 if DE or DE/MARG or FFP	8	

Table 2.3: Dependent Variable Used in the Ordered Logit Estimations (5 groups)

	Frequency	Mean
TYPE = 1 if RENEG	3	3,42
= 2 if FREE/NTEP/COST	10	
= 3 if NTEP	20	
= 4 if FP	30	
= 5 if DE or FFP	8	

Our hypothesis is that the degree of contractual rigidity chosen by the contracting parties is influenced by the factors highlighted by our model.

[8] In order to perform econometric tests on toll adjustment processes, we have decided to make two classifications of our contracts. One classification reduces the number of observed processes from 15 to 11; the second one from 15 to 5. Using the two classifications is a way to see how robust our results are according to the way adjustments are classified.

5. INFRASTRUCTURE CONCESSION CONTRACTS: DATA

5.1. Description of the Dataset of Contracts

We have constructed a dataset consisting of 71 toll road concession contracts (highways, bridges, tunnels). These 71 contracts refer to 45 original contracts and to 26 renegotiated contracts, referred to as “supplemental agreements”. These supplemental agreements correspond to non-anticipated agreed-upon modifications to the original contract[9], and the fact that they create new and different arrangements between the parties make it possible to consider them as new contracts (See Crocker and Reynolds 1993 for a similar methodology). Most projects in the sample (76%) are French, the rest concerns contracts from Greece, United Kingdom, Canada, Portugal, Benin, Chile and Thailand. Tables 2.4 and 2.5 show the distribution of the toll adjustment provisions according to their classification by country. The contracts have been devised with different operators. The oldest contracts in the sample were implemented in 1970, whereas the latest in 2005.

Table 2.4: Distribution of the Toll Adjustment Provisions (11 Groups) by Country

	COUNTRY								
TYPEADJUSTREGROUP 11	Benin	Canada	Chile	France	Greece	Portugal	Thailand	UK	**Total**
1				3					3
2				10					10
3				10					10
4				3					3
5		1		1				1	3
6					4				4
7				10					10
8			2						2
9				12					12
10		1	1	2		2			6
11	1			3			4		8
Total	1	2	3	54	4	2	4	1	71

Table 2.5: Distribution of the Toll Adjustment Provisions (5 Groups) by Country

	COUNTRY								
TYPEADJUSTREGROUP 5	Benin	Canada	Chile	France	Greece	Portugal	Thailand	UK	**Total**
1				3					3
2				10					10
3		1		14	4			1	20
4		1	3	24		2			30
5	1			3			4		8
Total	1	2	3	54	4	2	4	1	71

[9] In contrast to Crocker-Reynolds (1993), these supplemental agreements are not contract renegotiations due to the presence of NTEP or renegotiation provisions in the initial contract. These supplemental agreements follow from the willingness of the contracting parties to change some contractual terms, including in some cases the initial toll adjustment process.

5.2. Contractual Record

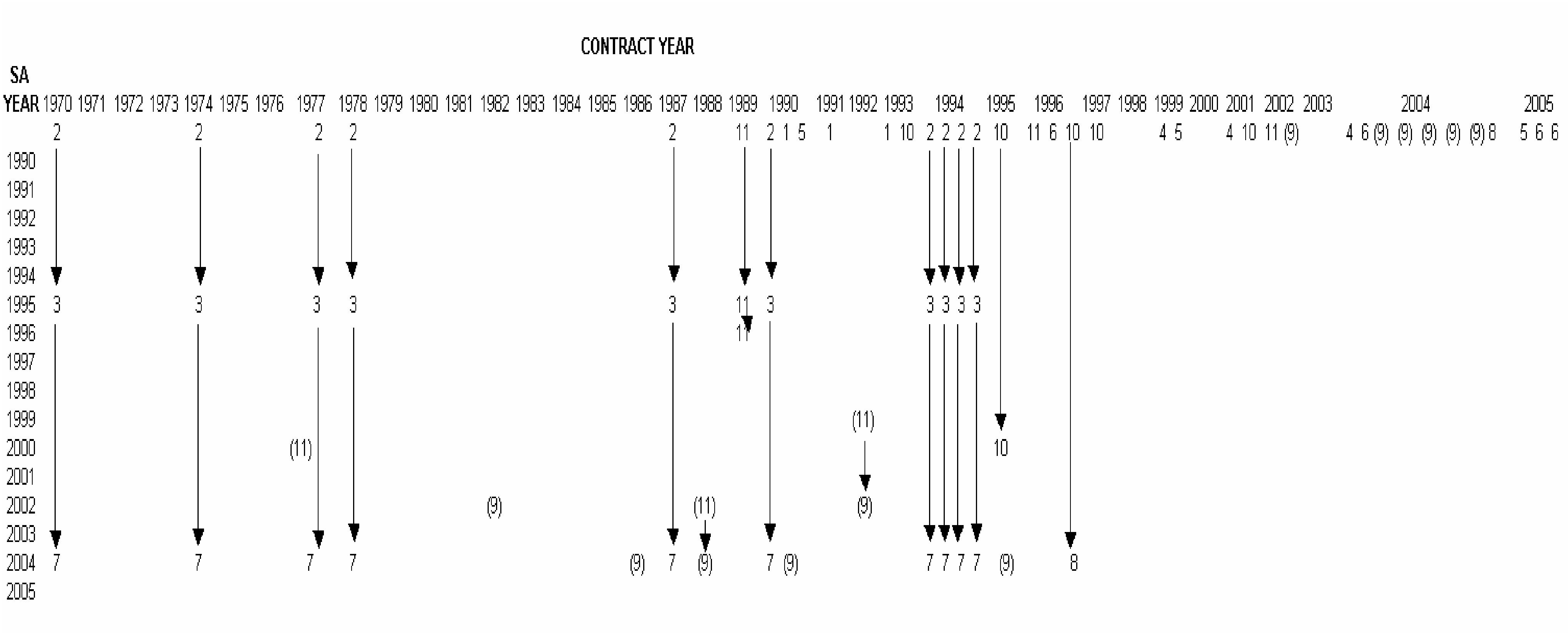
Using the convention for contractual rigidity from Table 2.2 (11 groups), we present the contractual record in Table 2.6. The horizontal axis identifies the year in which the contract was negotiated, and the vertical axis indicates the year in which an amendment to the original contract, *i.e.* a supplemental agreement, was implemented. Entries correspond to contractual observations, where contracts with private operators (semi-public companies) are those without (with) parentheses. For example, the concession contract originally negotiated in 1970 as a FREE/NTEP/COST contract was renegotiated in 1995 to establish a NTEP/EPA/MARG contract, and then in 2004, resulting in the more complete FP/EPA/MARG contract. Some contracts, such as the one negotiated in 1991, were never renegotiated.

Several aspects of this contractual record draw immediate attention. The first is the extensive use of contract renegotiation (34% of the original contracts were renegotiated at least once, and 57% of the original contracts signed before 2000 were renegotiated at least once). Contracts tend to be less rigid initially, anticipating renegotiation to a more rigid form at some future date.

A second important characteristic of the data is that road concession contracts have become substantially more rigid over time. Whereas the mean of adjustment types observed for the road concession contracts initially negotiated between 1970 and 2000 is 4,6, the mean of those signed between 2000 and 2005 is 7,6.

A final point worth noting is the apparent asymmetry between semi-public and private concessionaires. Contracts with totally private concessionaires are quite systematically less rigid than those with semi-public concessionaires. The contract year 2004 is, in this respect, very revealing. This is a counter-intuitive observation as one might expect contracts with semi-public concessionaires to be more flexible since they are supposed to behave less opportunistically, having quite the same interests as the State or its representative. In fact, in France, the State holds more than 90% of these semi-public concessionaires' capital (Cour des Comptes 1998). As a result, they may be considered as not-for-profit firms (Bennett-Iossa 2005).

Table 2.6 : Contractual Observations



5.3. Explanatory variables

The model developed in this chapter suggests several factors that are likely to influence the contractual degree of flexibility chosen by the parties.

Regarding variables affecting the marginal costs of contractual rigidity, the most prominent consideration is the extent to which the environment associated with the transaction is complex and uncertain. One of the primary sources of uncertainty facing parties during contractual negotiations over a road concession contract is the difficulty of forecasting future traffic with any confidence. This uncertainty on the future demand may be more or less important according to the context of the project. To quantify this traffic uncertainty, we surveyed a set of managers of a French private concessionaire, asking them to rate the traffic uncertainty surrounding each project (more information about the data collection process about traffic uncertainty is presented in Appendix 2.1). As a matter of fact, when negotiating a contract**,** the parties have expectations about the degree of traffic uncertainty likely to be experienced in the course of the exploitation phase. We capture this uncertainty in the explanatory variable *TRAFFIC,* which corresponds to the average rating between 1 and 5 given by managers regarding the traffic uncertainty for every contract. We made sure that the respondents gave consistent answers to all the questions, probing them if there was an inconsistency.[10] The hypothesis is that increasing traffic uncertainty, as reflected by an increase in the rate given by CEOs, should lead to more flexible arrangements.

This traffic uncertainty might also be accompanied by uncertainty on construction costs, although uncertainty on construction costs is far less important than the one on future traffic. The project may take more effort than estimated either because the conditions of construction are not those envisioned (discovery of an archaeological site, bad soil, soil contaminated…), or the project requires the use of innovative and untested technologies in the design and construction of infrastructure (it is mainly the case for bridges and tunnels). As for traffic uncertainty, data on construction costs uncertainty have been obtained from the rating by managers, on a scale from 1 to 5, of projects' complexity. To capture this effect, we include as an explanatory variable *COMPLEXITY*. We are confident that the figure we have obtained for the traffic uncertainty as well as for construction cost uncertainty are reliable. The hypothesis is that increasing project's complexity, as reflected by an increase in the average rate, should lead to more flexible arrangements.

[10] For each contract, we obtained at least three managers notations. Very few contracts have given rise to different notations.

Another important source of uncertainty stems from the difficulty of predicting future economic conditions with any confidence. We capture the increasing uncertainty associated with long time horizons in the variable *DURATION*, defined as the number of months between the completion of the infrastructure construction and the end of the concession. The hypothesis is that longer duration increases uncertainty and the costs of implementing more rigid contracts, leading to more flexible arrangements. Because contract duration is an endogenous variable, we correct for the possibility of endogeneity bias by substituting predicted value *DURATION** from reduced-form estimations of this variable[11] and using two-stage least square method (2SLS).

Regarding now the magnitude of renegotiation costs, the reputation of the contracting parties may serve as a useful guide. Indeed, as explained above, the public authority has the opportunity to take the concessionaire's reputation into account and consequently modify the contractual terms during the preferred bidder phase. In the same way, the concessionaire might not propose the same offer according to the procuring authority with which the concessionaire is dealing with.

There are several mechanisms by which reputation can evolve (Banerjee and Duflo 2000). First, in those cases where the public authority and the concessionaire[12] have contracted before, the presumption is that both had behaved reliably so that they both now have a better reputation with the other. We capture this effect in the variable *REPEATED CONTRACT*.

Second, as explained above, it is possible that differences in political ideology (e.g. left or right leaning public authorities) might affect contractual choices. In fact, on the one hand, left leaning public authorities are generally more skeptical than right leaning public authorities about the delegation of public services to private operators. This means that private concessionaires are supposed to have a better reputation among right wing public authorities. On the other hand, private operators anticipate that they will more likely be expropriated when the procuring authority is a left leaning authority. Thus, we expect that contracts negotiated with left wing authorities will be more rigid. We capture this effect in the variable *LEFT*.

Our model also yields one prediction about how contractual choices will differ across institutional and regulatory frameworks, which should reflect the likelihood of contractual

[11] In addition to the exogenous variables already used in the estimations, we included the country concerned by the contract and institutional variables reflecting corruption and quality of the bureaucracy in the country concerned by the contract. We obtained a $R^2 = 0{,}68$.

[12] The term concessionaire, regarding reputation issues, refers to the leader of the consortium.

renegotiation. In recent years, international institutions have developed numerous aggregate governance indicators. To capture the reliability of contract enforcement, we used the aggregate indicator *REGULATORY QUALITY* developed by the World Bank.[13] In fact, this indicator measures the capacity of the government to formulate and implement policies. More precisely, it includes measures of the incidence of market-unfriendly policies such as price controls or inadequate bank supervision, as well as perceptions of the enforceability of contracts and the burdens imposed by excessive regulation in areas such as business development. The hypothesis is that stronger institutional frameworks will more likely lead to rigid contracts. Nevertheless, this variable might reflect not only the probability to see the contract renegotiated but also the fact that a renegotiation will be less costly ($\overline{f} \rightarrow 1$), all things being equal. Therefore, the expected sign might be positive or negative, depending of which of these effects is dominating.

In addition, we include in the regressions several control variables. First, in our sample of contracts, we have 71 contracts that refer to 45 original contracts and to 26 renegotiated contracts, referred to as “supplemental agreements”. As pointed out before, we consider these supplemental agreements as new contracts (following Crocker and Reynolds 1993). We control for the possibility that these contracts are specific by using a dichotomous variable *SUP AGREEMENT*.[14]

Moreover, the ability of the procuring authority to negotiate price provisions depends on the number of bidders. The hypothesis is that the availability of alternative suppliers increases the negotiation power of the public authority during the preferred bidder phase, leading to the adoption of more rigid contracts. Thus, we include as an explanatory variable *NUMBER OF BIDDERS*.

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[13] Kaufmann, Kraay and Mastruzzi (2004) constructed indicators of six dimensions of governance: *Voice and Accountability* – measuring political, civil and human rights; *Political Instability and Violence* – measuring the likelihood of violent threats to government, including terrorism; *Government Effectiveness* – measuring the competence of the bureaucracy and the quality of public service delivery; *Regulatory Quality* – measuring the incidence of market-unfriendly policies; *Rule of Law* – measuring the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence; *Control of Corruption* – measuring the exercise of public power for private gain. We performed the regressions with all these indicators and results were always similar. We introduced the indicator *Regulatory Quality* in our analysis because interviews with French managers of a private concessionaire indicated that the relative ratings of this indicator match up best to their expectations.

[14] The main econometric results are not affected when considering only the sub sample without any supplemental agreements. Partial results are presented in section 7.

Furthermore, in our sample of contracts, there are private and semi-public concessionaires. We use the dichotomous variable *SEMCA*[15] as an additional control variable.

Finally, it has been emphasized in Section 5.2. that agreements tend to become more rigid over time. This may be a consequence of the reduction of traffic uncertainty out in time, but also of an evolution of the contractual practices due to a learning effect of the procuring authorities. Thus, to capture this effect, we incorporate in the estimates the variable *LEARNING EFFECT,* defined as the number of former contracts of the public authority with private concessionaires.

The variables used in our estimations are summarized in the following Table 2.7 and their distribution by country is given in Appendix 2.2. The correlation matrix is given in Appendix 2.3.

Table 2.7: Data Definitions and Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Definition
TYPE OF ADJUSTEMENT (5 GROUPS)	71	3.42	1.01	1	5	Ranking of toll adjustment types in 5 groups (See Table 3)
TYPE OF ADJUSTEMENT (11 GROUPS)	71	6.28	3.29	1	11	Ranking of toll adjustment types in 11 groups (See Table 2)
COMPLEXITY	71	2.20	1.29	1	5	Average rating on uncertainty on construction costs
TRAFFIC	71	2.39	1.14	1	5	Average rating on traffic uncertainty
LEFT	71	.31	.47	0	1	1 if the procuring authority is a left wing authority; 0 otherwise
REPEATED CONTRACT	71	5.27	4.21	0	11	Number of former interactions between the concessionaire and the public authority
SUP AGREEMENT	71	.46	.50	0	1	1 if the contract is a supplemental agreement; 0 otherwise
NUMBER OF BIDDERS	69	1.67	1.24	1	5	Number of bidders for the contract
DURATION	68	396.44	183.07	60	1164	Number of months between the completion of the infrastructure construction and the end of the concession
DURATION*	66	401.18	149.42	213.73	853.63	Predicted values for the variable DURATION using instrumental variables technic
LEARNING EFFECT	71	6.79	4.60	0	16	Number of former contracts of the public authority with private concessionaires
REGULATORY QUALITY	71	1.03	.31	-.48	1.82	Rating obtained by the country in question regarding this governance dimension (*Source* : World Bank)
SEMCA	71	.21	.41	0	1	1 if the concessionaire is a semi public company; 0 otherwise

6. ECONOMETRIC RESULTS

In order to study the way toll adjustment processes are chosen in public private partnerships, we have performed two set of estimates using ordered logit models.[16] The first set of

[15] SEMCA for semi-public companies concessionaires of highways.

estimates is concerned by our classification of toll adjustment types in 11 groups. The second set of estimates is concerned by our classification in 5 groups. Using the two classifications is a way to see how robust our results are according to the way adjustment types have been classified. Furthermore, we also add in a last regression for each classification (models 6 & 12) results we would obtain if our dependent variable was a continuous one instead of a qualitative one - to check the robustness of our results - using two-stage least square method.

Results are reported in Table 2.8. Models 1 and 7 contain only the exogenous variables *COMPLEXITY* and *TRAFFIC*. Models 2 and 8 take into account the reputation effect. Control variables have been then included in Models 3 and 9. They have fewer observations (69) because the number of bidders was not available for two contracts. Finally, we have included in Models 4 and 10 the variable *DURATION.* We use a two-steps ordered logit procedure in order to correct for the potential endogeneity problem we have with duration. Results are given in Models 5 and 11. Again, there are fewer observations because *DURATION* data are not available for concession contracts that have been awarded through Present-Value-of-Revenue auctions[17].

[16] In our case, it is not possible to use an OLS or 2SLS models because it imposes cardinality on the ordinal variables *TYPEADJUST5* and *TYPEADJUST11*. Using an ordered logit model, we consider the relationship $Y_i = \beta X_i + \varepsilon_i$ (i=1,2 ,..*n*), where *Y* is an unobserved latent variable, *X* is a set of explanatory variables and ε is a random disturbance. If we consider *Y* is in our case the price provision rigidity level, we cannot observe *Y* directly, but we can observe a category *j*, if $\mu_{j-1} \leq Y \leq \mu_j$. The use of an ordered logit model results in estimates of the thresholds μ as well as the distance between them. The use of an OLS model exogenously assigns both. Nevertheless, we provide the two types of estimates for checking how robust our results are.

[17] These auctions differ from auction mechanisms where the public authority sets a fixed concession term and firms bid tolls. Indeed, under a Present-Value-of-Revenue auction, bidders compete on the present value of toll revenue they require to finance the project. Thus, the concession ends when the present value of toll revenue is equal to the concessionaire's bid, *i.e.* the concession term is undefined. For a precise description of such an auction mechanism, see Engel-Fischer-Galetovic (1997).

Table 2.8: Estimation Results

	TYPEADJUST5						TYPEADJUST11					
	model1	model2	model3	model4	model5	model6	model7	model8	model9	model10	model11	model12
	Ordered Logit	Ordered Logit	Ordered Logit	Ordered Logit	Two Stage Ordered Logit	2 SLS	Ordered Logit	Ordered Logit	Ordered Logit	Ordered Logit	Two Stage Ordered Logit	2SLS
TRAFIC	-1.673*** (-4.993)	-2.617*** (-5.581)	-2.416*** (-4.424)	-2.800*** (-4.257)	-2.813*** (-4.328)	-0.635*** (-5.817)	-1.362*** (-4.718)	-2.561*** (-6.264)	-2.153*** (-4.802)	-2.429*** (-4.743)	-2.470*** (-4.782)	-2.133*** (-6.398)
COMPLEXITY	0.068 (0.303)	-0.184 (-0.755)	0.057 (0.178)	0.209 (0.588)	0.074 (0.204)	0.070 (0.752)	0.287 (1.336)	0.145 (0.683)	0.211 (0.722)	0.272 (0.873)	0.215 (0.668)	0.281 (0.993)
REPEATED CONTRACT		-0.278** (-3.113)	-0.461** (-3.288)	-0.254 (-1.576)	-0.209 (-1.302)	-0.061 (-1.596)		-0.366*** (-4.409)	-0.460*** (-3.738)	-0.254+ (-1.816)	-0.235+ (-1.727)	-0.329** (-2.838)
LEFT		1.764** (2.833)	1.336+ (1.849)	1.195 (1.545)	0.940 (1.250)	0.288 (1.582)		1.776** (3.198)	1.639* (2.483)	1.649* (2.411)	1.455* (2.204)	1.332* (2.392)
NUMBER OF BIDDERS			0.149 (0.454)	0.675+ (1.688)	0.467 (1.202)	0.187* (2.061)			0.406 (1.333)	0.979* (2.568)	0.833* (2.225)	0.805** (2.908)
SUP. AGREE			1.964* (2.285)	1.966* (2.125)	2.073* (2.259)	0.390+ (1.815)			1.331+ (1.827)	1.229 (1.636)	1.351+ (1.790)	0.473 (0.719)
REGULATORY QUALITY			-3.980** (-3.099)	-8.069*** (-4.007)	-8.207*** (-4.139)	-1.622*** (-4.698)			-2.963** (-2.829)	-6.155*** (-3.879)	-6.559*** (-4.096)	-4.087*** (-3.874)
LEARNING EFFECT			0.090 (1.001)	-0.063 (-0.476)	-0.173 (-1.189)	0.006 (0.158)			0.034 (0.435)	-0.115 (-1.020)	-0.161 (-1.374)	-0.012 (-0.113)
SEMCA			1.643+ (1.717)	1.593 (1.533)	1.977+ (1.823)	0.231 (0.940)			2.409** (2.917)	2.290** (2.714)	2.462** (2.848)	2.289** (3.054)
DURATION				-0.004+ (-1.840)						-0.003 (-1.477)		
DURATION*					-0.000 (-0.007)	-0.001 (-1.647)					-0.001 (-0.242)	-0.006* (-2.274)
Intercept	8.460*** (6.698)	13.181*** (6.268)	16.260*** (5.130)	22.850*** (5.199)	22.195*** (5.278)	6.606*** (12.789)	6.591*** (6.547)	12.267*** (7.062)	13.547*** (5.727)	18.221*** (6.138)	18.316*** (6.161)	16.529*** (10.475)
McFadden r2 / Pseudo R2	0.22	0.34	0.42	0.50	0.48	0.753	0.09	0.20	0.30	0.30	0.31	0.786
Log Likelyhood	-76.02302	-64.1877	-54.12007	-45.28638	-46.97244		-144.6992	-126.8796	-115.5318	-98.70075	-99.84397	
N	71	71	69	66	66	66	71	71	69	66	66	66

*Significance levels: + 0.10 * 0.05 ** 0.01 *** 0.001; t-stats in parentheses.*

The first striking result we observe is that the traffic uncertainty is clearly an important variable, driving the choice of toll adjustment type. More precisely, the higher the traffic uncertainty, the more flexible the toll adjustment provisions will be. This confirms our proposition 1, whatever the econometric model (1‰ significance level). In particular, a one standard deviation increase in our "traffic uncertainty" measure is associated with a decrease in the numerical value of the toll adjustment provision of 2 in our classification in 11 groups (Model 11), e.g. a shift of a toll adjustment provision of type 9 to type 7.

However, the complexity of the project is not significant. This might be explained by the fact that project's complexity concerns the construction phase and thus may not have an impact on the toll adjustment processes which in turn concern only the exploitation phase. In addition, in concession contracts, construction cost uncertainty is most often completely supported by the concessionaire. This result might also corroborate our assumption in the Chapter 1 that construction cost uncertainty is not important in toll road concessions, and might therefore be neglected.

Contracts of longer *DURATION* appear to favor more flexible toll adjustment processes in our estimates but this effect is not always significant according to the econometric specifications. This result could corroborate the prediction of our theoretical model: the longer the duration of the contract, the more uncertain the future economic conditions of the transaction, the more difficult it is to draft a rigid contract.

When we incorporate in the regressions variables reflecting contracting parties reputation (contracting parties' connivance), we observe that they all have a significant impact on price provisions, confirming our prediction 4. First, the *REPEATED CONTRACT* variable has a significant negative effect on the choice of the rigidity of the toll adjustment process, especially when considering our 11 groups classification: an increase in the number of former interactions between the contracting parties will decrease the rigidity of the toll adjustment provision chosen. This effect is significant in nearly all our specification models. In particular, the fact that the contracting parties already signed 10 previous contracts together is associated with a decrease in the numerical value of the toll adjustment provision of 2 in our classification in 11 groups (Model 11), e.g. a shift of a toll adjustment provision of type 9 to type 7. In addition, results indicate that left leaning procuring authorities are much more likely to provide rigid contracts than right leaning authorities. This finding, especially significant when considering our 11 groups classification, complements previous works on optimal contracting (Bajari, McMillan and Tadelis 2003) and runs against a recent study of

Levin-Tadelis (2005) in which the authors find that there is little correlation between voters' broader political preferences and contracting practices.

Table 2.8 also shows that in addition to finding a relationship between the rigidity of the toll adjustment provision and projects and contracting parties' characteristics, we found a significant correlation between the rigidity of the toll adjustment provision and institutional frameworks. In particular, our measure of the reliability of contract enforcement negatively correlates with the rigidity of the contract. In other words, the stronger the institutional framework, the more flexible the toll adjustment provisions will be. This result suggests that it is the second effect of strong institutions (See Section 5.3.) that prevails, *i.e.* strong institutions constitute an important impediment to contracting parties opportunism.

Finally, if we now turn to the effect of our control variables, we observe that the *NUMBER OF BIDDERS* variable is sometimes, depending on the specifications, significant and of the predicted sign, so that the availability of alternative suppliers increases the rigidity of contractual agreements. Supplemental agreements do not seem to be specific agreements as the dichotomous variable *SUP AGREEMENT* is not always significant, at least in our 11 group classification. We come back on this issue in the next section. This is partly consistent with the results obtained by Crocker and Reynolds (1993). In the same way, results indicate the absence of impact of a learning effect of the procuring authorities on the design of toll adjustment provisions. Finally, results show that we observe an impact of the type of the concessionaire, *i.e.* private or semi-public, on the toll adjustment provision chosen. The fact that the concessionaire is a semi-public company seems to rigidify the contract (especially regarding the classification in 11 groups). A simple explanation here is that semi-public concessionaires do not try to negotiate more flexible contractual terms since they have the same interests as the public authority (the semi-public companies in question are indeed quite completely public). Thus, if there is a renegotiation, there won't be haggling or friction, in contrast to renegotiations with private concessionaires.

7. ROBUSTNESS ANALYSIS

The econometric results are interesting and in line with our model. Nevertheless, they are also fragile for several reasons.

One possible limitation of our results would arise from ignoring a temporal evolution of the contractual practices regarding the design of the toll adjustment provisions. Indeed, as it has been emphasized in Section 5.2., agreements tend to become more rigid over time. This may be a consequence of the reduction of traffic uncertainty out in time, but also of an evolution of the contractual practices due to a learning effect or a change in political views. Thus, to capture this effect, we incorporate in the estimates the variable *TREND* (Models 13 to 15 of Table 2.9). Results show that such a trend does not exist and remain unchanged.

Another possible limitation lies in the fact that we considered supplemental agreements as original contracts. Even if we already incorporated a dummy variable to correct for the potential bias, we now perform our estimations on the sub sample composed only of original contracts (Models 14 and 16 of Table 2.9). Even if the number of observation decreases significantly, results are not at all affected.

However, the main limitation of our results, as already mentioned, stems from the fact that we have an unbalanced sample. To feel confident with our results and to be sure that the overrepresentation of French contracts does not drive our results (as the Appendix 2.2 seems to show), we performed our estimates using a dummy variable FRENCH for contracts signed in France (Models 17 to 20). Our main results still remain unaffected: we still observe strong political, institutional and uncertainty effects on contractual choices. Nevertheless, we also observe a "French effect", leading to more flexible contract compared to foreign agreements. Furthermore, introducing cross effects between on the one hand, our variables *FRENCH* and *REPEATED CONTRACT* and on the other hand, the variables *FRENCH* and *LEARNING EFFECT*, we observe both a repeated contract effect and a learning effect for our whole sample but only a repeated contract effect for the sub sample of French contracts. This is an interesting result calling for a better understanding of institutional differences that might explain such results. We also performed our estimates on the French contracts sub sample (Models 21 and 22 of Table 2.9) confirming those results.

Finally, whereas in our model we consider that the contracting parties make a dichotomous choice (*i.e.* they sign either a rigid contract or a flexible one), we allow for a continuous choice in our empirical analysis. To correct for this lack of adequation between the model and our empirical part, we propose a logit estimate, using *RENEGOTIABLE CONTRACT* as explained variable (dummy variable taking the value 1 if the type of the TAP actually chosen is between the types 7 and 11 included of our classification in 11 groups). Doing this, we look at the willingness of the parties to sign a contract that stipulates *ex ante* some *ex post* renegotiations. Results are presented in the Model 23 of Table 2.9; our main results still apply.

Table 2.9: Estimation Results

	TYPEADJUST5		TYPEADJUST11		TYPEADJUST5		TYPEADJUST11		TYPEADJUST5	TYPEADJUST11	RENEGOTIABLE
	model13	model14	model15	model16	model17	model18	model19	model20	model21	model22	model23
	Two Stage Ordered Logit	Two Stage Ordered Logit	Two Stage Ordered Logit	Two Stage Ordered Logit	Two Stage Ordered Logit	Two Stage Ordered Logit	Two Stage Ordered Logit	Two Stage Ordered Logit	Two Stage Ordered Logit	Two Stage Ordered Logit	Logit
TRAFIC	-3.081*** (-4.461)	-4.383*** (-3.922)	-2.546*** (-4.671)	-4.020*** (-4.345)	-2.737*** (-3.399)	-1.657+ (-1.959)	-2.363*** (-3.911)	-1.219* (-2.070)	-2.584* (-2.261)	-1.399* (-2.019)	22.859* (2.168)
COMPLEXITY	0.191 (0.510)	-0.282 (-0.506)	0.247 (0.750)	-0.231 (-0.487)	0.331 (0.678)	-0.098 (-0.214)	0.591 (1.432)	0.213 (0.541)	0.283 (0.506)	0.195 (0.447)	1.167 (0.987)
REPEATED CONTRACT	-0.183 (-1.130)	-0.088 (-0.465)	-0.230+ (-1.683)	-0.092 (-0.571)	0.062 (0.325)	-4.718* (-2.430)	-0.029 (-0.201)	-5.764** (-2.760)	-0.130 (-0.543)	-0.100 (-0.561)	2.087+ (1.815)
LEFT	1.063 (1.371)	0.297 (0.305)	1.474* (2.233)	0.384 (0.459)	2.270* (2.462)	2.387* (2.513)	2.187** (3.116)	2.692*** (3.434)	3.267** (2.810)	3.371*** (3.502)	-9.453* (-2.221)
NUMBER OF BIDDERS	0.739+ (1.650)	1.083* (2.116)	0.907* (2.221)	1.053* (2.378)	1.067* (1.962)	0.132 (0.303)	1.265** (2.649)	0.377 (0.923)	-0.594 (-0.827)	-0.431 (-0.684)	-3.677* (-2.323)
SUP. AGREE	2.142* (2.309)		1.381+ (1.818)		2.262* (1.997)	1.938+ (1.849)	1.102 (1.395)	0.743 (0.991)	1.915 (1.606)	-0.253 (-0.340)	3.505 (0.614)
REGULATORY QUALITY	-9.526*** (-4.173)	-8.259** (-3.059)	-6.866*** (-3.936)	-6.776** (-2.982)	-10.541*** (-4.190)	-8.245** (-3.099)	-8.823*** (-4.261)	-7.648** (-3.055)	-8.235+ (-1.922)	-7.169* (-2.132)	8.832* (2.135)
LEARNING EFFECT	-0.096 (-0.605)	0.051 (0.305)	-0.142 (-1.143)	-0.039 (-0.265)	0.983** (3.244)	0.285 (0.704)	1.186*** (4.573)	0.541 (1.619)	0.629+ (1.959)	0.971** (3.209)	-1.038* (-1.967)
DURATION*	-0.000 (-0.085)	-0.001 (-0.518)	-0.001 (-0.269)	-0.002 (-0.931)	0.000 (0.052)	-0.003 (-0.937)	-0.001 (-0.537)	-0.005 (-1.565)			0.035* (2.330)
SEMCA	2.013+ (1.816)	-3.069 (-1.163)	2.482** (2.862)	-3.971+ (-1.662)	3.007* (2.056)	1.864 (1.500)	3.077*** (3.403)	2.326** (2.600)			
TREND	-0.096 (-1.219)	-0.106 (-1.072)	-0.029 (-0.436)	-0.060 (-0.696)	-0.421** (-2.958)		-0.394*** (-3.325)				
FRENCH					-10.473*** (-4.239)	-10.022*** (-3.319)	-12.384*** (-5.656)	-14.018*** (-4.387)			
REPEATED CONTRACT * FRENCH						4.645* (2.372)		5.659** (2.694)			
LEARNING EFFECT*FRENCH						0.196 (0.357)		0.279 (0.626)			
Intercept	213.849 (1.358)	239.615 (1.210)	76.845 (0.572)	144.991 (0.846)	865.441** (3.025)	27.464*** (4.958)	809.491*** (3.381)	27.765*** (5.558)	19.832** (2.832)	12.807** (2.689)	-77.795* (-2.193)
McFadden r2	0.49	0.50	0.30	0.35	0.63	0.59	0.44	0.42	0.63	0.41	0.82
Log Likelyhood	-46.21246	-24.4971	-99.74914	-42.86556	-33.61508	-37.17431	-79.68973	-82.81771	-26.10998	-60.51498	-8.108938
N	66	34	66	34	66	66	66	66	53	53	66

*Significance levels: + 0.10 * 0.05 ** 0.01 *** 0.001; t-stats in parentheses.*

8. CONCLUSION

In deciding how to design a PPP, contracting parties face a choice between a flexible contract, in which parties plan to renegotiate price once uncertainty unfolds, and a rigid contract, in which parties cannot commit not to renegotiate but attempt to prevent renegotiation. In this chapter, we developed a simple incomplete contract theory model *with* renegotiation and maladaptation costs, based on the view that a contract provides incentives for private providers to innovate and adapt the public-service provision to unanticipated desirable service adaptation. This model yields tradeoffs between contractual flexibility and rigidity.

This leads to predictions about how contractual choices will vary across projects. Contracts for which uncertainty is low and hold-up severe are more likely to be rigid. We also argue that the tradeoff identified in the model will play out differently across contracting parties' characteristics. As renegotiation will inevitably occur when contracting parties decide to devise a flexible contract, they have to account for with whom they sign the contract. Reputation is therefore an important dimension. The model suggests that lower reputational capital of the contracting parties will more likely lead to rigid contracts. The model also leads to predictions about how contractual choices will vary across institutional frameworks. For instance, if the institutional framework of a country is such that the reliability of contract enforcement is weak, it will more likely lead to flexible contracts.

We used this model to interpret our empirical findings about the determinants of the contractual design of toll adjustment provisions in worldwide toll road concession contracts. Using data gathered from a variety of sources, we find that toll adjustment provisions in infrastructure concession contracts exhibit a wide diversity contrary to what is often written. But more interestingly, we find that contracts characterized by high traffic uncertainty are likely to be less rigid, and we provide strong evidence that contracting parties' characteristics impact on the contractual design. In particular, an increase in the number of former interactions between the contracting parties will decrease the rigidity of the toll adjustment provision chosen. In the same way, we find that contracts designed with left leaning procuring authorities are likely to be more rigid. These results confirm and emphasize the importance of trust in such agreements between a public authority and a private operator. Finally, we provide strong evidence that institutional environments impact on contract design, so that contracts designed in a strong institutional environment are likely to be more flexible.

Overall, our econometric results suggest that our simple model based on incomplete contract theory and transaction cost theory provides a useful framework for explaining contractual choices, at least regarding toll adjustment provisions. Thus, we show that such contracts are designed according to economic and political concerns, and more specifically, we show that contracting parties *do* design their contractual relationship according to the importance of renegotiation and uncertainty issues.

Our analysis leaves many questions open. For instance, we made strong assumptions about contracting parties' behaviour. In particular, we assumed benevolent public authorities, and we did not account for potential capture of public authorities by private providers. However, in our empirical analysis, the effect of our variable *REPEATED* on the contractual design could reflect such a capture of procuring authorities by private providers. It might therefore be an important topic for our future research to further develop our model in this direction.

In our empirical analysis, we pin down the contractual flexibility/rigidity of toll road concession contracts through the solely lens of the design of toll adjustment provisions. However, one might consider that toll adjustment provisions do not entirely reflect the degree of flexibility/rigidity of these contracts. In particular, other provisions of these contracts such as profit sharing provisions, or minimum income guarantee provisions can impact the general degree of flexibility of the contract in one way, and the design of toll adjustment provisions in the opposite way.

In addition, it would be interesting to study if a difference between the predicted and the observed type of toll adjustment provision translates in difference in performance, and more specifically in difference in the incidence of renegotiation.

Finally, our results suggest that further studies are needed to shed lights on the concessionaires' selection process in public-private contracts. Indeed, the efficiency of observed contractual agreements is also connected to the way concessionaires are selected (Bajari, McMillan and Tadelis 2003). To this end, it could be worth analysing whether flexible contracts, that rely more on trust and relational dimensions, are attributed through auctions with more subjective awarding criteria. This suggests that further research on the articulation of both *ex ante* and *ex post* dimensions of an auctioned public private contract is necessary.

Appendix 2.0: Proof for propositions 1 to 4

Looking at equation (16) we have the following condition for a rigid contract to be preferred to a flexible one:

$$\left[(1-\eta)\overline{f}+\eta\right]\cdot R(i^{rr})-i^{rr}-\overline{f}R(i^{f})+i^{f}\succ 0 \qquad \text{(16bis)}$$

We define $\rho(.)$ by the following equivalence

$$y=\rho(x)\Leftrightarrow x=\frac{2}{R'(y)}$$

In other words, for every x we have

$$R'\left[\rho(x)\right]=\frac{2}{x} \qquad \text{(A1)}$$

Then we have:

$$i^{f}=\rho(\alpha+\overline{f}) \text{ and } i^{rr}=\rho(\alpha+\overline{f}+\eta(2\underline{f}-\alpha-\overline{f})) \qquad \text{(A2)}$$

Differentiating in x the two members of equation (1), we obtain the derivative of $\rho(.)$:

$$\rho'(x)\cdot R''\left[\rho(x)\right]=-\frac{2}{x^{2}}\Leftrightarrow \rho'(x)=-\frac{2}{x^{2}\cdot R''\left[\rho(x)\right]}\succ 0$$

Thus function $\rho(.)$ is strictly increasing because $R(.)$ is supposed strictly concave.

Our problem boils down to study the mathematical properties of the function $\phi(\overline{f},\underline{f},\alpha,\eta)$ defined as:

$$\begin{aligned}\phi(\overline{f},\underline{f},\alpha,\eta)\equiv{}&\left[(1-\eta)\overline{f}+\eta\right]\cdot R\left\{\rho\left[\alpha+\overline{f}+\eta\left(2\underline{f}-\alpha-\overline{f}\right)\right]\right\}\\&-\rho\left[\alpha+\overline{f}+\eta\left(2\underline{f}-\alpha-\overline{f}\right)\right]-\overline{f}\cdot R\left\{\rho\left[\alpha+\overline{f}\right]\right\}+\rho\left[\alpha+\overline{f}\right]\end{aligned}$$

Studying the partial derivatives of function ϕ we obtain:

$$\begin{aligned}\phi'_{\overline{f}}={}&(1-\eta)R(i^{rr})-R(i^{f})+\left\{\left[(1-\eta)\overline{f}+\eta\right]\cdot R'(i^{rr})-1\right\}\cdot\frac{\partial i^{rr}}{\partial\overline{f}}\\&-\left\{\overline{f}\cdot R'(i^{f})-1\right\}\cdot\frac{\partial i^{f}}{\partial\overline{f}}\end{aligned}$$

$$\phi'_{\underline{f}}=\left\{\left[(1-\eta)\overline{f}+\eta\right]\cdot R'(i^{rr})-1\right\}\cdot\frac{\partial i^{rr}}{\partial\underline{f}}$$

$$\phi'_{\eta} = (1-\overline{f})R(i^{rr}) + \left\{\left[(1-\eta)\overline{f}+\eta\right]\cdot R'(i^{rr})-1\right\}\cdot\frac{\partial i^{rr}}{\partial\eta}$$

$$\phi'_{\alpha} = \left\{\left[(1-\eta)\overline{f}+\eta\right]\cdot R'(i^{rr})-1\right\}\cdot\frac{\partial i^{rr}}{\partial\alpha} - \left\{R'(i^{f})-1\right\}\cdot\frac{\partial i^{f}}{\partial\alpha}$$

The first term of each derivative is capturing the direct effect holding i^f and i^{rr} constant. The second term is the indirect effect that is coming through the variation of i^{rr}. The third term is the indirect effect that is coming through the variation of i^f. We can note that there is no direct effect for $\underline{f}$ and α. There is also no indirect effect transiting through i^f for $\underline{f}$, neither for η.

Knowing that from equation (2):

$$\frac{\partial i^{f}}{d\overline{f}} = \rho'\left[\alpha+\overline{f}\right]\succ 0 \qquad \frac{\partial i^{rr}}{\partial\overline{f}} = (1-\eta)\cdot\rho'\left[\alpha+\overline{f}+\eta\left(2\underline{f}-\alpha-\overline{f}\right)\right]\succ 0$$

$$\frac{\partial i^{f}}{d\underline{f}} = 0 \qquad \frac{\partial i^{rr}}{\partial\underline{f}} = 2\eta\cdot\rho'\left[\alpha+\overline{f}+\eta\left(2\underline{f}-\alpha-\overline{f}\right)\right]\succ 0$$

$$\frac{\partial i^{f}}{d\eta} = 0 \qquad \frac{\partial i^{rr}}{\partial\eta} = \left(2\underline{f}-\alpha-\overline{f}\right)\cdot\rho'\left[\alpha+\overline{f}+\eta\left(2\underline{f}-\alpha-\overline{f}\right)\right]$$

$$\frac{\partial i^{f}}{d\alpha} = \rho'\left[\alpha+\overline{f}\right]\succ 0 \qquad \frac{\partial i^{rr}}{\partial\alpha} = (1-\eta)\cdot\rho'\left[\alpha+\overline{f}+\eta\left(2\underline{f}-\alpha-\overline{f}\right)\right]\succ 0$$

We can also note that because

$$R'(i^{f}) = \frac{2}{\alpha+\overline{f}} \qquad R'(i^{rr}) = \frac{2}{\alpha+\overline{f}+\eta\left(2\underline{f}-\alpha-\overline{f}\right)} = \frac{2}{(1-\eta)\left(\alpha+\overline{f}\right)+2\cdot\eta\cdot\underline{f}}$$

We have

$$\overline{f}\cdot R'(i^{f})-1 = \frac{2\cdot\overline{f}}{\alpha+\overline{f}}-1 = \frac{\overline{f}-\alpha}{\alpha+\overline{f}}$$

And similarly

$$\left[(1-\eta)\overline{f}+\eta\right]\cdot R'(i^{rr})-1=\frac{2\cdot\left[(1-\eta)\overline{f}+\eta\right]-(1-\eta)\left(\alpha+\overline{f}\right)-2\cdot\eta\cdot\underline{f}}{(1-\eta)\left(\alpha+\overline{f}\right)+2\cdot\eta\cdot\underline{f}}$$

$$=\frac{(1-\eta)\overline{f}-(1-\eta)\alpha+2\cdot\eta\cdot\left(1-\underline{f}\right)}{(1-\eta)\left(\alpha+\overline{f}\right)+2\cdot\eta\cdot\underline{f}}$$

$$=\frac{(1-\eta)\left(\overline{f}-\alpha\right)+2\cdot\eta\cdot\left(1-\underline{f}\right)}{(1-\eta)\left(\alpha+\overline{f}\right)+2\cdot\eta\cdot\underline{f}}$$

Proof of proposition 1.

If we assume that

- $\overline{f}>\alpha$

We know

$$\overline{f}\cdot R'(i^{f})-1=\frac{2\cdot\overline{f}}{\alpha+\overline{f}}-1=\frac{\overline{f}-\alpha}{\alpha+\overline{f}}\succ 0$$

and $$\left[(1-\eta)\overline{f}+\eta\right]\cdot R'(i^{rr})-1=\frac{(1-\eta)\left(\overline{f}-\alpha\right)+2\cdot\eta\cdot\left(1-\underline{f}\right)}{(1-\eta)\left(\alpha+\overline{f}\right)+2\cdot\eta\cdot\underline{f}}\succ 0$$

It is then obvious that

$$\phi'_{\underline{f}}=\left\{\left[(1-\eta)\overline{f}+\eta\right]\cdot R'(i^{rr})-1\right\}\cdot\frac{\partial i^{rr}}{\partial\underline{f}}\geq 0$$

Proof of proposition 2.

If we assume that

- $\overline{f}>\alpha$
- $\eta\succ 0$
- $i^{rr}\succ i^{f}\Leftrightarrow\left(2\underline{f}-\overline{f}\right)\succ\alpha\Rightarrow\underline{f}\succ\dfrac{\overline{f}+\alpha}{2}$.

Then we have

$$\frac{\partial i^{rr}}{\partial\eta}=\left(2\underline{f}-\alpha-\overline{f}\right)\cdot\rho'\left[\alpha+\overline{f}+\eta\left(2\underline{f}-\alpha-\overline{f}\right)\right]\succ 0$$

And thus

$$\phi'_{\eta} = (1-\overline{f})R(i^{rr}) + \left\{\left[(1-\eta)\overline{f} + \eta\right] \cdot R'(i^{rr}) - 1\right\} \cdot \frac{\partial i^{rr}}{\partial \eta} \succ 0$$

<u>*Proof of proposition 3.*</u>

If we assume that

- $\overline{f} > \alpha$
- $\eta \succ 0$
- $i^{rr} \succ i^{f} \Leftrightarrow \left(2\underline{f} - \overline{f}\right) \succ \alpha \Rightarrow \underline{f} \succ \frac{\overline{f} + \alpha}{2}$.

Then we have

$$\phi'_{\alpha} = \left\{\left[(1-\eta)\overline{f} + \eta\right] \cdot R'(i^{rr}) - 1\right\} \cdot \frac{\partial i^{rr}}{\partial \alpha} - \left\{R'(i^{f}) - 1\right\} \cdot \frac{\partial i^{f}}{\partial \alpha}$$

Because of our assumptions concerning function $R(.)$ and our parameters η and $\overline{f}$, we know that

$$R'(i^{f}) \succ R'(i^{rr}) \text{ and } (1-\eta)\overline{f} + \eta \leq 1$$

Then

$$\left[(1-\eta)\overline{f} + \eta\right] \cdot R'(i^{rr}) - 1 \prec R'(i^{f}) - 1 \quad \text{and} \quad \frac{\partial i^{rr}}{\partial \alpha} \prec \frac{\partial i^{f}}{\partial \alpha}$$

Thus we have

$$\phi'_{\alpha} = \left\{\left[(1-\eta)\overline{f} + \eta\right] \cdot R'(i^{rr}) - 1\right\} \cdot \frac{\partial i^{rr}}{\partial \alpha} - \left\{R'(i^{f}) - 1\right\} \cdot \frac{\partial i^{f}}{\partial \alpha} \prec 0$$

<u>*Proof of proposition 4.*</u>

If we assume that

- $\overline{f} > \alpha$
- $\eta \succ 0$
- $i^{rr} \succ i^{f} \Leftrightarrow \left(2\underline{f} - \overline{f}\right) \succ \alpha \Rightarrow \underline{f} \succ \frac{\overline{f} + \alpha}{2}$.
- $\eta \succ \frac{R(i^{rr}) - R(i^{f})}{R(i^{rr})}$

We have

$$(1-\eta)R(i^{rr}) - R(i^{f}) \prec 0$$

Following the same reasoning as in proof of proposition 3, we obtain

$$\phi'_{\overline{f}} = (1-\eta)R(i^{rr}) - R(i^{f}) + \left\{\left[(1-\eta)\overline{f} + \eta\right] \cdot R'(i^{rr}) - 1\right\} \cdot \frac{\partial i^{rr}}{\partial \overline{f}}$$
$$- \left\{\overline{f} \cdot R'(i^{f}) - 1\right\} \cdot \frac{\partial i^{f}}{\partial \overline{f}} \prec 0$$

Lastly, we can find some values of our parameters for our inequality (16) to be respected. To show this, note that

$$\phi(\overline{f}, \underline{f}, \alpha, 0) \equiv 0$$

Suppose $\underline{f} \succ \frac{\overline{f}+\alpha}{2}$, and let choose values for $\underline{f}, \overline{f}, \alpha$ such that this condition is met, then:

$$\phi(\overline{f}, \underline{f}, \alpha, \eta) = \underbrace{\phi(\overline{f}, \underline{f}, \alpha, 0)}_{=0} + \int_{0}^{\eta} \phi'(\overline{f}, \underline{f}, \alpha, x)dx$$

Indeed, if $\underline{f} \succ \frac{\overline{f}+\alpha}{2}$ we have $\phi'_{\eta}(\overline{f}, \underline{f}, \alpha, \eta) \succ 0$ so $\phi(\overline{f}, \underline{f}, \alpha, \eta) \succ 0$

Appendix 2.1: Data Collection about Traffic Uncertainty

Some of the data used in this chapter (*TRAFFIC*, *COMPLEXITY* and *NUMBER OF BIDDERS*) were collected by interviews with three different persons of a French private concessionaire: the CEO and two other senior persons. The interviews were conducted separately and the respondents did not have any idea of the purpose of the project. Most of the projects were negotiated or renegotiated over the last ten years, and the persons we interviewed have more than 15 years of seniority in the firm. They therefore had no difficulty answering the questions. Regarding very old contracts, at least one of the three interviewees was able to answer us for each of the contracts since the firm keeps contracts' memory green. Thus, cross-checking of information was not always possible for every old contract but data was available.

For every contract, respondents were asked to rate between 1 and 5 the traffic uncertainty likely to be experienced in the course of the exploitation phase that they expected at the time of contract negotiation (rating 1 corresponding to a contract in which the traffic uncertainty is very low, *i.e.* the respondents have a good idea of future traffic, and 5 the opposite). Nevertheless, to facilitate the interviews and obtain comparable answers from respondent to respondent as we were conducting the interview we used a structured questionnaire so as to recall the respondent the general background of each project. This questionnaire (not exhaustive) is the following one:

1/ Regarding the tolling culture of the country in question: are toll roads well established or are there no toll roads in the country? (So as to estimate uncertainty over toll acceptance)

2/ Regarding toll-facility details:

- Is the infrastructure in question an extension of existing roads or a Greenfield site?
- Is the infrastructure in question a stand-alone facility or does it rely on other, proposed improvements?
- Are there few competing roads or many alternative roads?
- Is there only road competition or multimodal competition?

3/ Regarding the users:

- Are there few, key origins and destinations or multiple origins and destinations?
- Is the demand profile flat or highly seasonal and/or "peaky"?

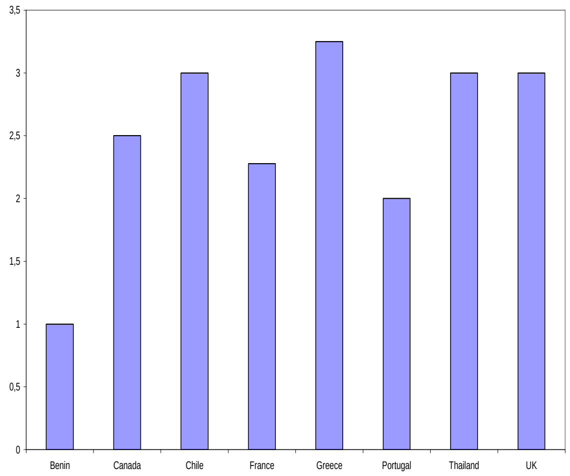
- Is the income, time sensitive market high or low?

4/ Is the local/national economy strong or weak?

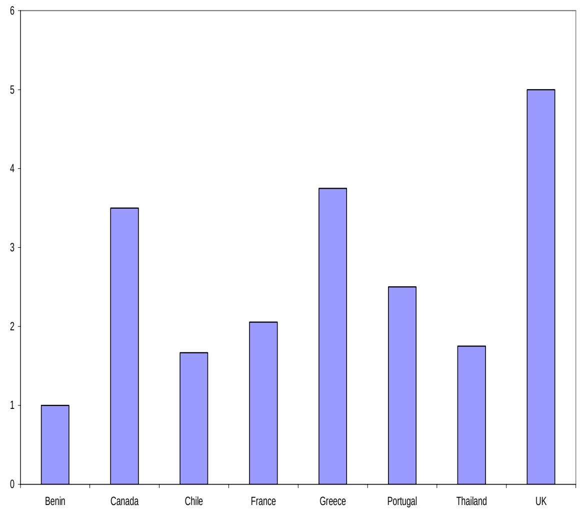
Once the respondent answered to these questions, he was more able to give an accurate rating of the traffic uncertainty of the project in question on a scale between 1 and 5.

Furthermore, when we did not obtain comparable answers from senior to senior, we probed until we reached consistency (which was usually easily done).

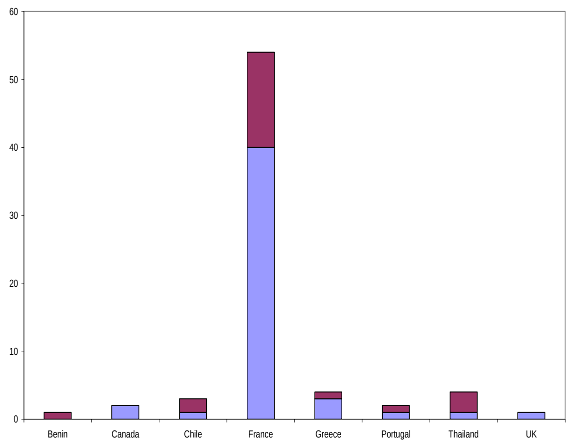
Appendix 2.2: Explanatory Variables Distribution by Country



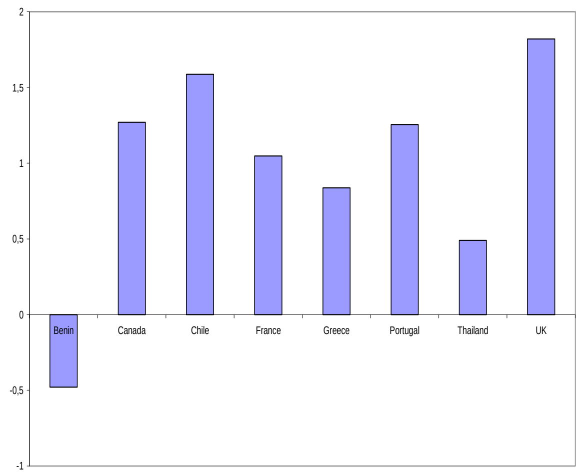
(a) Average of Traffic Uncertainty



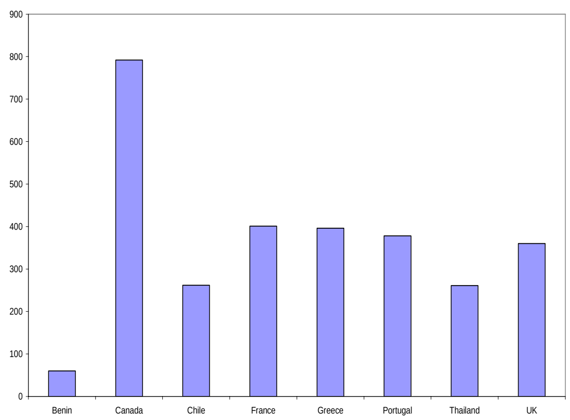
(b) Average of Complexity



(c) LEFT (Blue : 0 ; Red : 1)



(d) Regulatory Quality



(e) Average of Duration

Appendix 2.3: Correlation Matrix

	TYPEADJUST11	TYPEADJUST5	TRAFFIC	COMPLEXITY	REPEATED CONTRACT	LEFT	NUMBER OF BIDDERS	SUP. AGREEMENT	LEARNING EFFECT	REGULATORY QUALITY	DURATION	DURATION*	SEMCA
TYPEADJUST11	1.0000												
TYPEADJUST5	0.9229	1.0000											
TRAFFIC	-0.5446	-0.6776	1.0000										
COMPLEXITY	-0.2628	-0.4335	0.6536	1.0000									
REPEATED CONTRACT	0.0280	0.2394	-0.6896	-0.5242	1.0000								
LEFT	0.2390	0.1080	0.2088	0.2439	-0.2780	1.0000							
NUMBER OF BIDDERS	0.0173	-0.1682	0.4611	0.5702	-0.6644	0.0443	1.0000						
SUP. AGREEMENT	0.1781	0.4218	-0.5771	-0.6279	0.6032	-0.0812	-0.5161	1.0000					
LEARNING EFFECT	0.2195	0.3918	-0.7328	-0.5370	0.7770	-0.2267	-0.4439	0.5239	1.0000				
REGULATORY QUALITY	-0.4438	-0.4993	0.1270	0.1730	0.0977	-0.1549	0.0930	-0.0913	-0.0776	1.0000			
DURATION	-0.3452	-0.3761	0.3954	0.5095	-0.3393	0.0778	0.4850	-0.3743	-0.1436	0.1048	1.0000		
DURATION*	-0.3506	-0.4105	0.4791	0.6174	-0.4111	0.0942	0.5877	-0.4535	-0.1740	0.1270	0.8254	1.0000	
SEMCA	0.5228	0.4291	-0.5234	-0.2834	0.4446	0.1343	-0.2885	0.1250	0.4953	-0.0799	-0.3175	-0.3847	1.0000

CHAPTER 3

POLITICAL ACCOUNTABILITY, INCENTIVES, AND CONTRACTUAL DESIGN OF PUBLIC PRIVATE PARTNERSHIPS: DEMAND RISK ON PRIVATE PROVIDERS OR PUBLIC AUTHORITIES?[1]

The first chapter has shown that uncertainty and informational asymmetries, leading to the internalization of the winner's curse by bidders, as well as renegotiations, leading to lowballing bidding behaviour, are defining and striking features of toll road concessions that one needs to consider to enhance the efficiency of these contracts.

In the previous chapter, we have developed a model that shows that one way to contain inefficiencies due to potential *ex post* opportunism and uncertainty is to adapt the contractual design accordingly. We have then tried to empirically examine whether the observed choices of contractual design in the particular case of toll road concessions were driven by the tradeoffs highlighted by our model. We found that contracting parties are aware of the economic tradeoffs involved in the design of such contracts and do adapt the contract according to their expectation of the magnitude of renegotiation and uncertainty issues.

[1] This chapter started while the author was a visiting scholar at Yale and wishes to thank Eduardo Engel for his helpful comments.
This chapter was presented at the invited session "Public Private Partnerships", presided by J. Pouyet, at the 56th annual congress of the AFSE, Paris, September 19-21 2007.
The author gratefully acknowledges comments and suggestions from David Azema, Olivier Desbiey, Matthew Ellman, Pierre Garrouste, Vincent Piron, Jérôme Pouyet, Maher Said, Stéphane Saussier, and participants at the 56th annual congress of the AFSE, Paris, September 19-21 2007, and at the ATOM Research seminar.

However, this way of dealing with uncertainty and renegotiation issues, though hampers their distorted effects on private providers' incentives to innovate, may not curb the strategic bidding behaviour that we have highlighted in the first chapter, which consists in lowballing in the expectation of renegotiation that mainly the high uncertainty associated with traffic forecasts renders possible, favouring then private providers with political connections, not the most efficient ones.

One potential solution to this aggressive bidding behaviour may consist in not imposing the demand risk on the private provider. Major works on this topic are the ones of Engel, Fischer and Galetovic (1997, 2001, 2002, 2003 and 2007). The authors suggest resorting to a new auction mechanism, called Least-Present-Value-of-Revenue (LPVR) auction. These auctions differ from standard auction mechanisms where the public authority sets a fixed concession term and firms bid tolls, to the extent that, under such a mechanism, bidders compete on the present value of toll revenue they require to finance the project. Thus, the concession ends when the present value of toll revenue is equal to the concessionaire's bid, *i.e.* the concession term is undefined. Such an auction mechanism permits therefore to eliminate the demand risk, which is desirable if the main source of demand uncertainty is exogenous, which we have shown in the first chapter. In addition, the authors explain that LPVR auctions reduce the scope for renegotiation to the extent that, first, they reduce the problems caused by contractual incompleteness, and, second, they make it easier for the public opinion to detect opportunistic renegotiations favouring the private provider, since the revenue required by the winning bid is a clear benchmark for any wealth transfer.

In practice, although we observe the implementation of LPVR auctions in some countries (mostly in Chile), the trend around the world has been increasingly to adopt availability contracts to move away from the concession model. The availability contract, as the concession contract, is a long-term, global, fixed-price contract – *i.e.* the procuring authority offers the private provider a prespecified price for completing the project – on the design, building, financing and operation of a public service and consists in output specifications systems. As the concession contract, it also formally delegates to the private provider sufficient residual control rights to provide the service free of interference. The main difference between these two contractual practices concerns the demand risk, which is borne by private providers in the concession contract and by procuring authorities in the availability contract. Thus, under a concession contract, the private provider's remuneration depends on the demand for the public service whereas under an availability contract, it comes from service payments by the procuring authority according to performance criteria (the contract specifies penalties in case the performance and quality criteria are not met; there is therefore no link with the service demand). As highlighted in the general introduction, this trend towards the adoption of availability contracts concerns countries of the five continents, even though it is particularly pronounced in Europe, with the leading figure of the United Kingdom which launched availability contracts – designated by the acronym PFI "the Private Finance Initiative" – in 1992[2], and all public services (See Figures 2 and 3 of the general introduction).

While it is commonly thought that availability contracts are used when it is not possible to make users pay or when the services are not profitable, we observe in practice, on the one hand, that some contracts specify that the service provider is remunerated according to the service demand even if users do not pay (they are most often known under the name "shadow toll contracts") and, on the other hand, that procuring authorities resort to availability contracts, and hence make the remuneration of the service provider dependent on continuity of service supply, while users pay a toll to them. Thus, it appears that the choice between a concession and an availability contract, that is to say between a contract in which the private provider bears the demand risk and a contract in which it does not, depends neither on the ability to make users pay nor on the profitability of the service in question.

As theory and practice so far seem to converge towards the fact that contracts in which private providers do not bear the demand risk solve many of the difficulties inherent to toll road concessions, a major question is therefore the following one: Are availability contracts, or more generally contracts in which private providers do not bear the demand risk, a better option for contracting-out to a private provider the provision of public services than concession contracts?

As already highlighted, stringent worries regarding PPPs in general and toll road concessions in particular concern the *ex post* adaptation inflexibilities inherent to these long-term contracts. So far, as already discussed, studies (except Ellman 2006) have explained the *ex post* adaptation problems by the distorted incentives for the private public-service provider to invest in the research into innovative approaches to carrying out the service provision (Hart, Shleifer and Vishny 1997, Hart 2003, Bennett and Iossa 2006). However, it seems that public authorities have also an important role to play in the adaptation of private public-

[2] Over 900 PFI projects with a capital value of £40bn have been signed in the UK, with about 500 of them operational (HM Treasury 2004).

service provision over time for the following reasons. First, any PPP is between a public authority and a private public-service provider; that is there is no direct democracy (the public cannot vote directly to select and oust the private provider). Second, there is no market accountability of private providers, since the price applied to consumers, if any, is a regulated price, not a market price. Finally, public authorities, as elected delegates of consumers, are duty bound to discover adaptations and consumers' preferences and to exercise pressure on the private provider to adapt the public service to satisfy the changes in the effective consumers demand. The importance of the role of public authorities in the delegation of the provision of public services to private providers was pointed out by David Hinchliffe[3], according to whom: "[T]he key to reforming the public sector is not the profit motive, but democracy and accountability".

Thus, political accountability, *i.e.* the responsiveness of public authorities to consumers concerns, has also to be considered when one aims to tackle the issue of the inefficient development of PPPs over time. In other words, we have to consider public authorities as active players instead of passive bystanders of the general efficiency of PPPs. Ellman (2006) is the unique author to our knowledge that theoretically raises the question of the accountability of public authorities in private provision of public services. More precisely, in this paper, the author compares private with public provision regarding political and public accountability. To this end, he relies on the framework of Hart, Shleifer and Vishny (1997), but considers that the government and the public are involved in service adaptation. He shows that privatisation can, first, demotivate the government from investigating and responding to public demands because privatisation allows the provider to hold up service adaptations, and, second, demotivate the public from mobilising to pressure for service adaptations, since providers indirectly hold up the public by inflating the government's cost of implementing these adaptations. Thus, in this paper, the tradeoff is between public and private provision. In his model, privatisation takes implicitly only one form, the form of the availability contract (he assumes that private providers' remuneration never depends on the demand), and private providers' adaptation incentives do not vary with the governance structure.

In this third chapter, *we aim to investigate how the contractual design of PPPs – availability versus concession contracts – affects not only private providers' incentives to adapt the service provision, but also, and above all, public authorities' incentives to be responsive to consumers concerns.*

[3] David Hinchliffe, Chair, House of Commons Health Select Committee, in Pollock, Shaoul and Player (2001).

To this aim, we present an incomplete contract theory model in which: (1) public authorities (e.g. government, mayors) are involved in adaptation, *i.e.* exert effort to respond to consumers demands; (2) consumers may have the power to sanction private providers; (3) private providers exert efforts to cut costs and discover adaptations.

First, we show that public authorities end up having to pay more for unanticipated desirable service adaptations when the private provider does not bear the demand risk than when it does. This is due to the fact that under a concession contract consumers are empowered, *i.e.* have the ability to sanction and oust the private provider, which provides procuring authorities with more credibility in side-trading and thus greater incentives to be responsive. Second, we show that contracts in which the private provider bears the demand risk most often dominate contracts in which it does not bear the demand risk regarding private providers' cost reducing incentives. This is due to the fact that when the demand risk is on private providers, they may have some incentives to internalise the effects of their cost-reducing investments. Third, we show that concession contracts can provide greater adaptation effort incentives to private providers than availability contracts. This is due to the fact that there might be private gains from implementing the adaptation under a concession contract, so that private providers can, under certain conditions, implement the adaptation without any further inducement.

As a consequence, we show that there is a lower matching with consumers preferences over time under an availability contract than under a concession contract. In other words, we show that contracts in which private providers do not bear the demand risk rule more out the accountability – regarding service adaptations – of public authorities and private providers to individual consumers than when they bear the demand risk. The striking policy implication of this chapter is that the trend towards a greater resort to availability contracts, or more generally to contracts in which the private provider does not bear the demand risk, instead of concession contracts, so as to avoid their intrinsic uncertainty and renegotiation issues, may not be optimal. This is all the more true that the belief that private providers do not bear a demand risk in availability contracts could be an illusion. The tradeoff between these two types of contracts depends above all on the availability of alternative provisions so consumers are able to exercise their power of sanctioning private providers.

The chapter is organised as follows. Section 1 presents the related literature. In Section 2, we illustrate the underlying logic in the context of three examples. Section 3 presents the basic model of the choice between availability contracts and concession contracts and solves it. Section 4 extends the model with the endogeneisation of the effort of the private provider and discusses the complementarity or substitutability of procuring authorities' and private providers' incentives. Section 5 extends the model with the consideration of the risk of default of procuring authorities when private providers do not bear the demand risk. Section 6 discusses the results and speculates about the application of the analysis to different sectors. Section 7 concludes.

1. RELATED LITERATURE

This chapter is linked to the incomplete contract literature, while focusing on the contractual design, instead of ownership structures, as the former chapter. In addition, in contrast with previous studies, we approach in this chapter the issue of contractually unanticipated service adaptation not only from the point of view of the distorted incentives for the private public-service provider, but also from a political accountability point of view.

This chapter is also linked to the literature on the political economy of government responsiveness. For instance, Besley and Burgess's (2001 and 2002) model derives how governments become more responsive to people when people become more aware of how government actions affect them, which is determined by the freedom of the press. Also, Besley and Ghatak (2003) tackle the question of the best process by which service providers, consumers and procuring authorities come together to create an organization. This could be governed by choice, as when a parent picks a school for their child, or by government policy. The authors show, in a non formalized way, that empowering consumers, by allowing them to choose between providers with different service provisions, is a potentially source of welfare improvements. They explain that empowering consumers means that the nature of the principal-agent problem changes. While the centralized model of public-service provision (illustrated in Figure 3.1) has two layers of agency problems: between consumers and elected officials and between the government and the service provider, the structure of the problem when consumers of public services are empowered (as shown in Figure 3.2), provides a closer link between them and service providers. Thus, empowering consumers can offer a better matching between consumers and providers; that is a greater allocative efficiency.

Figure 3.1

$$\begin{tikzcd}[row sep=large]
\text{Consumers} \arrow[d] \\
\text{Procuring authority} \arrow[d] \\
\text{Private public-service provider}
\end{tikzcd}$$

Figure 3.2

$$\begin{tikzcd}
\text{Procuring authority} \arrow[dr] & & \text{Consumers} \arrow[ll] \arrow[dl] \\
& \text{Private public-service provider} &
\end{tikzcd}$$

This approach underpins the representation developed in this chapter of the accountability mechanism for service adaptations under the two differing contractual procedures. While the centralized model of public-service provision illustrated in Figure 3.1 corresponds to the accountability structure implied by an availability contract, the model in which consumers are empowered (Figure 3.2) fits with the accountability structure of a concession contract (or more generally of models in which private providers bear the demand risk, e.g. shadow toll contracts). As a matter of fact, under concession contracts, consumers are empowered to the extent that the remuneration of the private provider depends on the demand for the service. Thus, under such contracts, consumers have the power to sanction the service provider by not using the service any more, depending on the availability of alternative options. Making the private provider bear the demand risk can then empower consumers, which can then lead to a better alignment on service provision preferences.

2. EVIDENCE

This section illustrates the underlying logic of the chapter in the context of three case studies.

2.1. The School Catering Case

The recent experience of the British government with school dinners offers a good example of the incentives provided by an availability contract, *i.e.* a contract in which the private provider does not bear the demand risk. According to Ellman (2006), "In the aftermath of a series of television reports on school diners by celebrity chef Jamie Oliver in early 2005, the government rushed to quench mounting public discontent over low quality committing to make improvements. However, new schools locked into 25-year contracts through private finance initiatives (PFIs) are finding that they cannot rid their menus of junk food despite the government's pledge".

This case highlights the fact that, under an availability contract, if there is a shock in demand like a fundamental change in the consideration of healthy food by the public, the procuring authority has very low power to make the private provider adapt the service accordingly. By contrast, we can imagine that if the demand risk was on the private provider, *i.e.* its remuneration depends on the demand for the public service (in contrast to the fixed payment if performance criteria are met), the public would have had the possibility to oust the private provider in case of non-adaptation to their demand by, for instance, providing their children with a home-made lunch. This would have had consequently increased the credibility of the procuring authority to sideline the incumbent private provider for not adapting to healthier ingredients.

This logic also applies in the following case of the London Underground Public Private Partnership.

2.2. London Underground Public Private Partnership

The London Underground Public Private Partnership is a long-term PFI contract that provides for maintenance and upgrading work of the London underground (trains, tracks, signalling and stations). This is a thirty-year, £30bn contract between London Underground Limited and the main private service provider Metronet. Metronet holds two of the three thirty-year contracts to maintain track and trains covering the London underground network. One contract covers the Bakerloo, Central, Victoria and Waterloo & City deep-level Tube lines; the other covers the Metropolitan, District, Circle and other sub-surface lines that run in shallow tunnels. The service provider took over responsibility for the lines in April 2003. It followed a competitive process whereby the contract was awarded to the qualified bidder offering the specified service at the lowest price (availability charge). Monthly payment to Metronet derives from a performance adjusted Infrastructure Service Charge (ISC). In other words, the payment to Metronet, for the first period of the contract (the contract is divided in 4 periods of 7,5 years), is composed of a fixed ISC (94,6% of the revenues determined for the first period) and of performance revenues (that account for 5,4% of the revenues determined for the first period of the contract). The performance revenues depend on the execution of the renewal works. They are determined according to the statistics of incidents and performance of the two last years preceding the contract. There are four criteria:

(+) *Capability*: technical capability of the lines, maximal capacity to reduce the durations of the trips;

(+) *Availability:* time lost by users (trains speed reduction);

(+) *Ambience*: global service quality perceived by, assessed by independent surveys;

(-) *Service points and Specific Projects*: penalties are applied in case of failure to meet the specified standards (regarding mainly trains delayed).

75% of the performance revenues stem from technical improvements (Capability).

Moreover, in case of disputes, the contract specifies the intervention of an independent "Statutory Arbiter", designated by the Secretary of State.

The extent of Metronet's problems has been clear since November 2006, when the arbiter of the PPP contract said he expected the company to overspend by £750m in the first 7½ years of its contract, up to October 2010. Mr Livingstone, London's Mayor, has for long assumed that London Underground would end up paying none of the £750m of overspending. Yet, Metronet is moving closer to initiating a formal independent review to decide who pays for a projected £750m cost overrun. Andrew Lezala, of Metronet Rail, went on: ""I respect the fact that there are large sums involved here and we are quite prepared to go through the extraordinary review process, and that's quite likely" (Robert Wright, April 25 2007).

Whereas the grounds of this overspending are not clear, this case however highlights the fact that, in the framework of availability contracts, when there are *problems* regarding the service provision (not only regarding contractually unanticipated service adaptation), it is very difficult for the procuring authority to reach an agreement with the private provider. In this particular case of London Underground Public Private Partnership for instance, the private manager is not afraid to face a long settlement of dispute and huge costs. We could however imagine that if the demand risk was on Metronet, users would have been able to sanction Metronet for delivering a service of bad quality, and hence empowered London Underground in the negotiation process.

2.3 Cofiroute: The Episode of the "Shipwrecked Men of the Road" of Saint-Arnoult-In-Yvelines

Cofiroute is the main French highway concessionaire. They operate under concession contracts, *i.e.* its remuneration depends on the demand for the highway and more particularly stems from the tolls charged to users.

January 4, 2003, the French Weather-Forecaster underestimates the extent of the falls of snow which will fall down on the French North and Centre, preventing the installation by

Cofiroute of the provisions necessary to preserve the viability of base joint A10-A11. Thus, when plates of glaze appeared on this joint base, already dense circulation became completely blocked. The absence of measures such as the diversion of traffic and information of the users by Cofiroute increased the number of users blocked out of 60 km.

After this event, there was a public discontent about the lack of suitable means in case of considerable falls of snow. As a consequence, Cofiroute invested in less heavy salting vehicles as well as in automatic salting systems located in crucial points.

Thus, in contrast with the former ones, this case study highlights the fact that under a concession contract, in case of a changing public demand or problems, service adaptation can occur.

Thus, these various case studies highlight the fact that the underlying problem with availability contracts is that they often prevent procuring authorities from exploiting adaptation gains in the absence of private providers' cooperation. If a crucial change in demand or a fundamental problem in the way the public service is provided occurs, procuring authorities have very low power to lead private providers to adapt the service provision. This might be explained by the low credibility in side-trading procuring authorities have. By contrast, under a concession contract, consumers have the power to oust private service providers by sidelining them with alternative options. This strengthens the credibility of procuring authorities to replace or sideline the incumbent private provider for not adapting to consumers demands or dealing with provision problems, since in case of sidelining, the incumbent can experience negative profits (waste of economies of scope in side-trading are then largely reduced). So, it seems that under availability contracts, private providers can hold up procuring authorities from a greater share of its gain from adaptation than under concession contracts. This is what the model developed in the following section proposes to show.

3. THE MODEL

This section presents a simple model of the choice by procuring authorities between availability and concession contracts for the provision of a public service by a private provider (such as health care, transportation, water, education or school dinner catering), derived along the lines of Ellman (2006). We consider first the model in which the private public-service provider does not make any effort to adapt the service. We endogenise the accountability of procuring authorities (politicians) to changing consumers' demands by introducing a special third actor – the consumers of the public service – within Hart, Shleifer and Vishny's, henceforth denoted HSV, framework.

So, in our model, there are two players: a procuring authority PA (e.g. a mayor, local government, or the national government) and the private service provider PM (private manager), and a special third player, the users of the public service (the consumers) *C*, that can influence PA and PM but cannot contract with them. More specifically, we assume in this model that consumers play a role only through their ability to sanction the private provider when the latter bears the demand risk. In other words, in this model, consumers are considered as a semi-player to the extent that we do not analyse the interactions between them and public authorities, assuming that public authorities always reflect consumers' preferences. Such an assumption is motivated by the fact that we consider core public services, to which consumers are very sensitive, and hence the adaptations they require are most often politically salient.

PA organises the service provision on the consumers' behalf. PA always delegates the service provision to a private manager (PM), but can choose between a contract in which the private provider does not bear the demand risk (an availability contract) and a contract in which the private provider bears the demand risk (e.g. a concession contract) to this end. Both contracting procedures formally delegate to the private provider sufficient residual control rights to provide the service free of interference, and they both are long-term contracts (we assume of the same length). Nevertheless, under both types of contract, PA and PM may still need to negotiate to adapt their contract over time. So, ongoing negotiation is needed for adaptation in both cases.

As already mentioned, there is one crucial difference between these two contractual forms. Under availability contracts, the remuneration of the private provider is not dependent on the demand but stems from service payments from PA according to performance criteria. By contrast, by imposing on the private public-service provider the demand risk (either through users' toll or through payments from PA depending on the demand, as in shadow toll contracts), concession contracts empower consumers, *i.e.* make it possible for consumers to sanction PM to the extent that if they do not use the service it provides, the private provider's remuneration is affected. Nevertheless, we cannot speak about "direct democracy" in the sense that the contract remains between PA and PM only, neither about market accountability since the price (or toll if consumers pay) paid to PM for the provision of the public service is the price regulated by the contract (not a market price). Thus, under both types of contract, if an adaptation is required, not only the adaptation but also and above all the price adaptation will have to be negotiated between PA and PM. Service adaptation can therefore occur only if PA and PM reach an agreement on the adaptation and the price adaptation. The hope is then that PA will pressure PM to adapt the public service to satisfy the changes in the effective demand. The demand/availability distinction matters because it affects what happens when PA and PM have to negotiate to make PM adapt to unanticipated changes in the service provision.

3.1. Benchmark Model

At the start of their relationship, PA and PM negotiate a basic contract X, that can be either an availability contract or a concession contract. We assume that X just compensates PM for standard costs of provision, whatever the contractual design.

We do not consider the cost of public funds because, in both contractual procedures, the funding can either stem from users' tolls or from public funds. We are only interested in whether the private provider bears the demand risk (in which case PM's remuneration can stem from public funds as in shadow-tolls contracts or from users' tolls) or not (in which case PM's remuneration can stem from users' tolls that are collected by PA or from public funds).

X generates a (net) payoff of b for PA and $w(e)$ for PM where $w(e)$ is PM's cost advantage (over a standard provider) from investing e in specialising to PA[4]. In other words, we assume that this cost-reduction investment e by PM is fully relationship-specific, *i.e.* if PM does not provide some service for PA, neither PM nor PA gets any benefit from e. We assume that e is bounded so $e \in [0, \bar{e}]$. As in HSV's model, we assume that this cost-reduction investment is accompanied by a reduction in quality $q(e)$[5].

The investment e is not contractible and nor is his payoff implications $w(e)$ and $q(e)$. The following regularity assumptions guarantee sufficiency of first-order conditions.

[4] Since in both contractual designs, PM has control rights over the service provision, e will be implemented unilaterally.
[5] However, it is not obvious that the quality effects of cost-reducing investments are only negative. Nevertheless, considering positive effects on quality of e will not change the results of our model.

Assumption 1. $w(0)=0$, $w''(e)<0<w'(e)\forall e\geq 0$ and $\lim_{e\to 0_+} w'(e)=\infty, \lim_{e\to\infty} w'(e)=0$.

Assumption 2. $q(0)=0, q'(e)\geq 0, q''(e)\geq 0 \forall e\geq 0$.

Assumption 3. $w'-q'>0$, *i.e.* the net effect of cost reducing investments is always positive[6].

Availability contract: the private provider does not bear the demand risk

Under an availability contract, PM's overall payoff is $t_0+w(e)-e$, where t_0 is the payment that PM receives for the provision of the basic public service. PM does not internalise the adverse quality effect $q(e)$ as quality is noncontractible.

PA's overall payoff is then $b-t_0-q(e)$.

Concession contract: the private provider bears the demand risk

Under a concession contract, consumers are empowered to the extent that they can oust the private provider in case of non satisfaction with the service provision. The magnitude of this faculty depends mainly on the availability of alternative providers[7]. So we use the parameter λ to capture the impact of the pressure exercised by consumers on PM's remuneration, where $\lambda\in[0,1]$.[8] For $\lambda=0$, it is not necessary that all consumers switch to an alternative provision to make PM experience negative profits. Indeed, the profitability of most concessions contracts is very sensitive to the demand, *i.e.* a marginal change of the demand can generate negative profits for the private provider.

Under such a contract, PM will then internalise the negative effect on quality of its cost-reducing effort according to the value of λ. For instance, if we consider the case when $\lambda=0$, PM would not make any revenue if it does not internalise the quality effect of its cost-reducing investment Thus, in such a case, PM will internalise the full adverse quality effect $q(e)$. Conversely, if $\lambda=1$, PM will not at all internalise the adverse quality effect of e, since its remuneration would be the same whether internalising $q(e)$ or not.

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[6] This assumption may be strong but as we assume that e is bounded, it is not that restrictive to assume that this assumption holds everywhere in the domain. It is in fact much less restrictive than assuming that e is unbounded and that this assumption holds everywhere, like in HSV's and related models. This assumption implies that we consider only public services for which PM's cost-reducing efforts provoke quality damages that are always smaller than the gains in cost reduction they entail. This assumption seems however to match the features of numerous public services for which quality criteria are contractible *ex ante*.

[7] Note that it is not necessary that the alternative provisions are adapted to consumers' preferences. Consumers can in fact decide to switch to an alternative provision that can even less match their preferences, so as to sanction the private provider.

[8] This boils down to assuming that the demand shock of an adaptation can only be negative. In other words, we assume that private providers' remuneration is bounded and can only be reduced by the changing demand.

Thus, if the impact of the pressure exercised by consumers on PM's remuneration is λ, PM's overall payoff is

$$t_0 + w(e) - (1-\lambda)q(e) - e$$

PA's overall payoff is then $b - t_0 - \lambda q(e)$.

3.2. Adaptation and Political Accountability

While PM invests e to cut costs, PA, as elected delegate of consumers, invests effort i to discover what the consumers want and how to satisfy their demands. So i represents PA's efforts to pay attention to consumers concerns about service quality. For instance, when there is a consumers' demand for a concrete change, i raises the probability that PA recognises that the demand is serious and raises the probability that PA works out how to satisfy consumers demands – in terms of pressure exercised on PM to satisfy the change in effective consumers demand for instance. This effort permits then PA and PM to adapt the basic contract X to changing consumers' preferences.

We assume that consumers pressure is independent of PA's attentiveness and contractual design.[9]

We denote the corresponding adapted contract by Z, again with the non-contingent transfer set to just compensate the standard cost of provision. For simplicity, we assume that e helps PM to satisfy Z so that PM's net payoff from enforcement of contract Z is again $w(e)$. In other words e reduces PM's costs by the same amount whether providing the basic or the adapted service. We also assume that e has the same adverse effect on quality $q(e)$ whether providing the basic or the adapted service. PA's additional surplus from Z is $v(i)$ where $v \geq 0$, increasing and concave in i, represents the net gain in consumers welfare from the adaptation. In other words, $v(i)$ measures PA's success in identifying or discovering adaptations that are valued by consumers[10]. So $v(i)$ can be interpreted as a

[9] We neglect the effort investments of consumers to discover improved policies and technologies because Ellman (2006) already models the public's role in creating accountability and proves that private providers indirectly holdup consumers by inflating the procuring authority's cost of implementing these adaptations. Thus, the higher the hold-up of the procuring authority's gains from adaptation, the lower the pressure of consumers. Considering consumers' effort will therefore not change the results but will strengthen the dominance of the contract for which the procuring authority's incentives are higher. In addition, we can consider that consumers have always binding time and budget constraints.

[10] If we consider that procuring authorities are not benevolent and then have for only objective the maximisation of their re-election chances, the adaptations required by consumers will have to be also politically salient. Again,

measure of PA's responsiveness to consumers demand – how likely it is that PA manages to please consumers. Attentiveness i raises PA's ability and propensity to respond.

If PA pays PM subsequent transfers (or toll increases) t in case of adaptation, then, normalizing time discounting to zero, PA and PM's overall payoffs from Z are:

When PM does not bear the demand risk

$$u_{PA} = b - t_0 - q(e) + v(i) - t - i$$

$$u_{PM} = t_0 + t + w(e) - e$$

When PM bears the demand risk

$$u_{PA} = b - t_0 - \lambda q(e) + v(i) - t - i$$

$$u_{PM} = t_0 + t + w(e) - (1-\lambda)q(e) - e$$

The investment i is not contractible and nor is its payoff implications $v(i)$. The following regularity assumption guarantees sufficiency of first-order conditions.

Assumption 4. $v(0) = 0, v''(i) < 0 < v'(i) \forall i > 0$ and $\lim_{i \to 0_+} v'(i) = \infty, \lim_{i \to \infty} v'(i) = 0 \forall i \geq 0.$

Parties are risk-neutral and PA has rational expectation about the renegotiation process when it makes its investments, *i.e.* it can make correct calculations about the expected returns from any action. We assume information is symmetric and PM and PA negotiate a symmetric Nash bargain.[11] So Z is enforced in equilibrium. Contractual design and the availability of alternative providers matter because they affect default outcomes in bargaining and hence the equilibrium choices of i and e. We capture these effects in a simple four-stage model. ***Timing***:

Stage 1: PA chooses the contract design (Concession contract, Availability contract) for contract X and negotiates with PM over stage 4 contract X, fixing the basic remuneration of the service provider t_0.

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we do not consider the case when consumers' and public authorities' benefits from adaptation are not proportional to the extent that we consider core public services, to which consumers are very sensitive.

[11] Thus, as in the previous chapter, we assume that the public authority does not maximize the global surplus during renegotiations: its utility function is given by the welfare of the rest of society, excluding the private operator. The same justification applies; that is the political process aligns the public authority's and society's interests (since the private operator has negligible voting power, its interests receive negligible weight).

Stage 2: PA and PM sink their investments i and e. We assume for now that the private provider does not invest in the research into innovative approaches to carrying out the service provision, but this assumption is dropped in Section 4.

Stage 3: Renegotiation takes places to allow the adaptation to be implemented in the service provision: PA and PM negotiate over stage 4 the contract Z and additional transfer t (or toll increases).

Stage 4: PA and PM trade (jointly or with their market alternatives).

The remuneration t_0 agreed at stage 1 cannot depend on observed investments, for it is not possible to specify in advance the delivery of a specific adaptation. So it plays no role in determining investment efficiency. The subsequent transfer t, negotiated on top of contract Z at stage 3, is the share of PA's adaptation surplus that PA in equilibrium has to give to PM, in excess of its adaptation costs. It depends on the stage 3 default payoffs which in turn depend on the contractual design, as we will show.

PM is assumed to maximize its profits. PA maximizes the social benefit, net of the payment to PM. In this setting, the first-best levels of investments (e^*, i^*) maximize $b + v(i) - i + w(e) - q(e) - e$. Hence, they satisfy

$$v'(i^*) = 1$$

$$w'(e^*) - q'(e^*) = 1$$

with $e^*, i^*>0$.

As both contracts are with a private provider, in default of renegotiation, we assume that PA is not able to exploit entirely investments i. This is due to the fact that under each type of contractual design, PA and PM commit to X at stage 1, PA cannot therefore switch to alternative trades (except if they break the contract, which is prohibitively expensive). PA might however still engage in "side-trades" with other private or public providers PM' to provide the service adaptation alongside the basic public service provided by PM (this might be possible either through the implementation of a new provider, or through the resort to already available alternative provisions).[12] Nevertheless, this market access by PA is rarely so effective: (1) PA may not be able to credibly duplicate the basic service by buying the adapted service from PM' unless the additional value from adaptation is very high; (2) even

[12] We assume that PM''s additional cost of providing the adapted service is the same as for PM. Furthermore, we assume competition is such that PA needs only to compensate PM''s costs.

when it is technologically feasible to have PM' provide the adaptation service without the basic service, this would waste the economies of scope from having a single party provide and coordinate them. To capture PA's reduced market access, we assume that PA only appropriates a fraction $(1-k)$ of the adaptation return $v(i)$[13], where $k \in]0,1]$ captures the "market-shielding" effect of PPP. This actually boils down to an asset-specificity effect. In addition, PM's side-trading returns are independent of i and e, so we normalise PM's additional side-trade value to 0.

Effort when the private provider does not bear the demand risk

Under an availability contract, PA's default payoff is:

$$b - t_0 + (1-k)v(i) - q(e)$$

Normalising PM's alternative payoff to 0, PM's default payoff is $t_0 + w(e)$. This is due to the fact that the contract protects PM's cost-reduction efforts, by forcing PA to pay a fixed price for the basic service, provided that performance criteria are met. So PM appropriates the full cost reduction $w(e)$.

PA's maximal gain from renegotiation is therefore $kv(i)$.

PA and PM's renegotiation gains are ½ of this sum. So PA chooses i to maximise

$$b - t_0 + (1-k)v(i) - q(e) + \tfrac{1}{2}\left[kv(i)\right] - i \tag{1}$$

and PM chooses e to maximise

$$t_0 + w(e) + \tfrac{1}{2}\left[kv(i)\right] - e \tag{2}$$

The first-order conditions are now

$$v'(i) = \frac{2}{2-k} \qquad w'(e) = 1 \tag{3}$$

Effort when the private provider bears the demand risk

When the contract imposes the demand risk on the private provider, in case of non adaptation, consumers can sanction the private provider. The magnitude of this faculty depends on the availability of alternative providers (in the case of a highway, we can imagine that users, if

[13] Recall that $v(i)$ is PA's net benefit, *i.e.* entails PM's costs of adaptation.

their changing demand is not satisfied, can sanction the private provider by using another road, or by taking the train etc. See also the above example with school catering). So, again, we use the parameter λ to capture the impact of the pressure exercised by consumers on PM 's remuneration, with the availability contract being equivalent to the setting $\lambda = 1$[14].

Under such a contract, PA has more power and credibility to exploit investments i. In fact, consider that the number of consumers that switch to an alternative provider in case of default of renegotiation is such that $\lambda = 0$, implying no profits for PM. In such a case, PA is able to appropriate the full margin return $v(i)$ by negotiating with PM' (no market-shielding effect any more) because PA is able to switch – instead of side-trading – to alternative trading. Thus, if the impact of the pressure exercised by consumers on PM 's remuneration is λ, PA 's default payoff is

$$b - \lambda t_0 + (\lambda(1-k) + (1-\lambda))v(i) - q(e)[1 - \lambda(1-\lambda)] = b - \lambda t_0 + (1 - k\lambda)v(i) - q(e)[1 - \lambda(1-\lambda)]$$

In default of renegotiation, PM may not appropriate the full cost reduction $w(e)$. This is due to the fact that consumers will switch to alternative provisions, which, in the case of a concession contract, will lead to lower profits for PM, and hence a weaker internalisation of $w(e)$ by PM. In addition, PM may also suffer from the adverse effect on quality $q(e)$ of its cost reduction effort e, but, in case of default, only regarding the consumers that still use the service even if it is not adapted. PM 's default payoff under a concession contract is then

$$\lambda[t_0 + w(e) - (1-\lambda)q(e)]$$

PA 's maximal gain from renegotiation is therefore

$$\lambda k v(i) + (1-\lambda)w(e)$$

The gain from renegotiation is shared between the parties through a Nash-bargaining solution, so PA chooses i to maximise

$$b - \lambda t_0 + (1 - k\lambda)v(i) - q(e)[1 - \lambda(1-\lambda)] + \frac{1}{2}\left[k\lambda v(i) + (1-\lambda)w(e)\right] - i \tag{4}$$

and PM chooses e to maximise

$$\lambda[t_0 + w(e) - (1-\lambda)q(e)] + \frac{1}{2}\left[k\lambda v(i) + (1-\lambda)w(e)\right] - e \tag{5}$$

[14] We abstract from the transaction costs of designing an availability contract compared to a concession contract, which when λ = 1 would favour the concession contract. See the discussion part.

The first-order conditions are now

$$v'(i) = \frac{2}{2-\lambda k} \qquad w'(e) - q'(e)\left[\frac{2\lambda(1-\lambda)}{(\lambda+1)}\right] = \frac{2}{\lambda+1} \tag{6}$$

3.3. Accountability and Incentives Comparisons

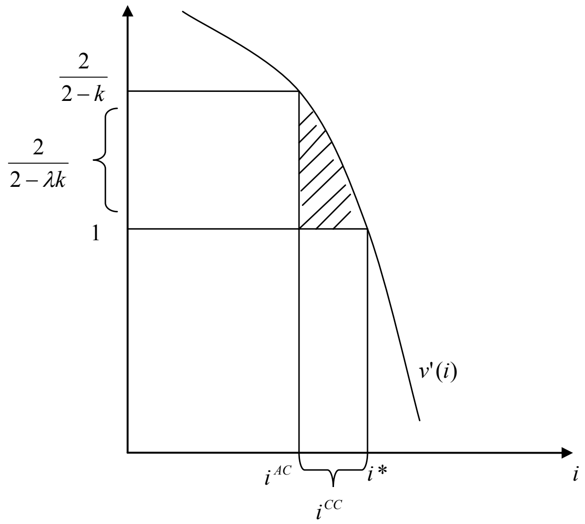
Political accountability

The above first-order conditions demonstrate how a contract in which the private provider bears the demand risk increases PA's incentives to support adaptations from the marginal incentive $(2-k)/2$ of $v'(i)$ in equation 3 to $(2-\lambda k)/2$ of $v'(i)$ in equation 6. Under an availability contract, PM is able to hold up PA of its investments i, because PA is not totally able to exploit i by replacing or sidelining an uncooperative PM. Under a concession contract, PM can also be able to hold up PA, but it will depend on the value of λ. More specifically, the greater the impact of the pressure exercised by consumers on PM's remuneration, *i.e.* the smaller λ, the smaller the renegotiation surplus for PA, so the smaller the holdup of PM of PA's adaptation investments. In the case of $\lambda = 0$, PA's incentives to support adaptations when the private provider bears the demand risk, are equivalent to the first-best incentives level. Accordingly, $i^* \geq i^{ConcessionContract(CC),\lambda} \geq i^{AvailabilityContract(AC)}$ for any λ. The following proposition records these points.

> **Proposition 1**. *Procuring authorities are more attentive and responsive to consumers demand when the private provider bears the demand risk. Increasing the impact of the pressure exercised by consumers on PM's remuneration increases the political accountability. So, $i^{CC}(\lambda) > i^{AC}$ $\forall \lambda < 1$, and* $\frac{di^{CC}(\lambda)}{d\lambda} < 0$ $\forall \lambda > 0$.
>
> **Proof.** See Appendix 3.1

The proposition, illustrated by the following Figure 3.3, states that the model in which the private provider bears the demand risk (like in concession contracts) always dominates the model in which the private provider does not bear any demand risk (like in availability contracts) regarding the political accountability, *i.e.* regarding the incentives given to the procuring authority to invest efforts to pay attention to consumers changing demands. Intuition follows from the fact that the procuring authority has more credibility in side-trading under a concession contract than under an availability contract, since the incumbent private provider can experience negative profits.

Figure 3.3: Illustration of equilibrium levels of political accountability

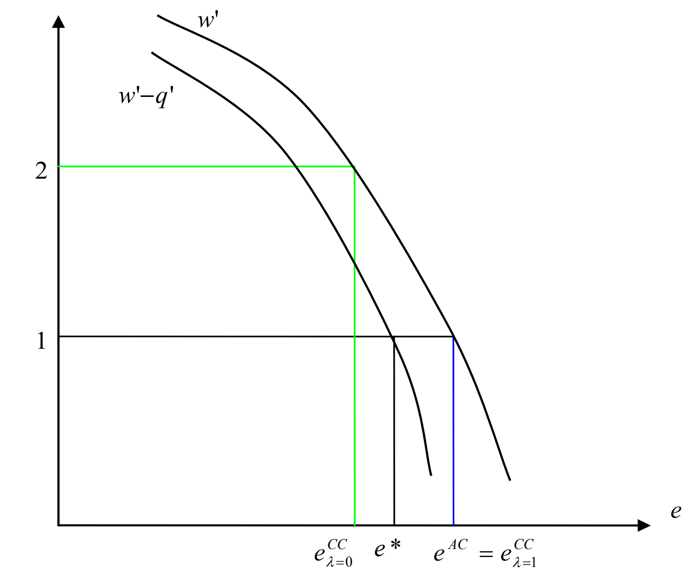


Private provider's cost-reducing incentives

The above first-order conditions also demonstrate how a concession contract decreases PM's cost-cutting incentives compared to an availability contract. As a matter of fact, the model shows that for λ equal to 1, PM's cost-cutting incentives under a concession and under an availability contract are equivalent and over-optimal. However, when λ tends towards 0, PM's cost-cutting incentives under a concession contract, e^{CC}, tend to be smaller than under an availability contract. They may become exactly equal to e^* for some λ and then continue to decrease and get further away so that, for a range of values of λ, there is under-investment in e under a concession contract. Finally, e^{CC} may be, for λ close to zero, further away from e^* than e^{AC} is.

The following Figure 3.4 and proposition illustrate and record these points.

Figure 3.4: Illustration of equilibrium levels of private providers' cost-reducing incentives



Proposition 2. *i) The private public-service provider's incentives to invest in cost-reducing efforts are smaller when it bears the demand risk than when it does not, i.e.* $e^{AC} \geq e^{CC}$ for any λ. *Whether the private provider bears the demand risk or not is optimal depends on the value of λ and on the functional forms for* $w(e)$ *and* $q(e)$. *Without making further assumptions about the functional forms for q(e) and w(e), it is not possible to pin down a particular value of λ that makes the contractual forms equally inefficient.*

ii) Increasing the impact of the pressure exercised by consumers on PM *'s remuneration, i.e. a smaller* λ, *decreases its incentives to invest in cost-reducing efforts, i.e.*

$$\frac{de^{CC}(\lambda)}{d\lambda} > 0 \forall \lambda > \frac{1}{4}$$

Therefore, when $\lambda > \frac{1}{4}$, *there is a unique value of λ* for which the two contractual forms are equally distant from the first best for each form for* $w(e)$ *and* $q(e)$. *Below this cut-off λ*, the contract in which the private provider does not bear the demand risk is optimal, and above this cut-off, the contract in which the private provider bears the demand risk is optimal.*

iii) Since $e^{AC} \geq e^{CC}$ *and* $e(\lambda)$ *is increasing* $\forall \lambda > \frac{1}{4}$, *there is a range of values of λ around 1 where the contract in which the private provider bears the demand risk is* *always closer to the first best than the contract in which the private provider does not bear the demand risk.*

Proof. See Appendix 3.1

Intuitively, if the private provider bears the demand risk, it internalizes the negative externality of e according to the potential impact of the consumers' pressure on its remuneration. In contrast, under an availability contract, in case of adaptation or not, PM never internalises the adverse quality effect. Then, PM's cost reducing efforts under a concession contract can only be lower than under an availability contract.

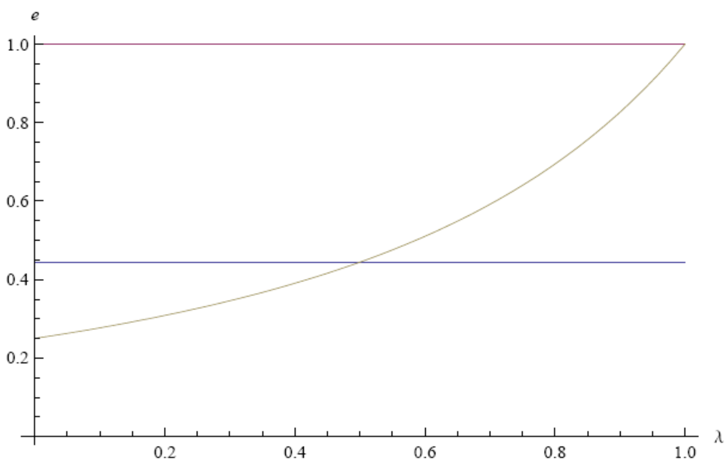
In addition, the greater the impact of consumers' pressure on PM's remuneration, the more PM will internalize the negative externality and then the smaller e ; conversely, the lower the potential impact of the pressure exercised by consumers on PM's remuneration, the lower the internalisation by the private provider of the adverse effect on quality of its cost reducing investments and hence the higher its cost reducing efforts.

However, this does not imply that the concession contract always dominates the availability contract. As a matter of fact, if λ tends towards zero, there is under-investment in e under a concession contract, and for λ close to zero, depending on the functional forms for $w(e)$ and $q(e)$, PM's cost-reducing incentives when it bears the demand risk might be further away from e^* than when it does not bear the demand risk. This is due to the fact that in case of non-adaptation and λ close to zero, PM will not be able to internalise $w(e)$.

The fact that PM may not be able to appropriate the full $w(e)$ in case of default of adaptation when it bears the demand risk explains why availability contracts will be always more optimal than concession contracts *if we do not consider the effect of cost-reducing efforts on quality* (since under an availability contract, in case of adaptation or not, PM always appropriates the full cost-reduction effort).

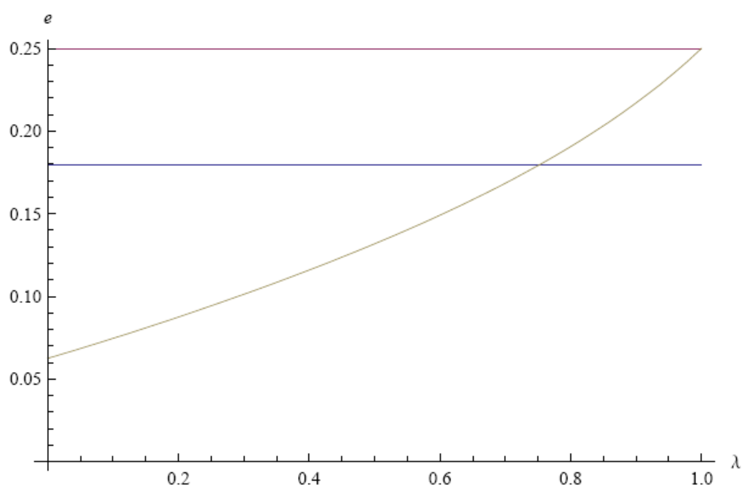
The consequence is that clear-cut results are not obtained when we consider the adverse effect of e on quality. Whether the private provider bears the demand risk or not is optimal depends on the functional forms for $w(e)$ and $q(e)$. Thus, without making further assumptions about the functional forms for $w(e)$ and $q(e)$, it is not possible to pin down a particular value of λ, λ*, that makes the two contractual forms equally inefficient. However, for a *particular* form for $w(e)$ and $q(e)$, it is easy pin down the λ* that makes the two contractual forms equally inefficient. The following Figures 3.5 and 3.6 give also *an illustration* of the situations where a contract in which the private provider bears the demand risk is either always optimal (Figure 3.5), or not always (Figure 3.6).

Figure 3.5: Case where the concession contract is always optimal.



In this example, we have $w(e) = 2\sqrt{e}$ and $q(e) = \dfrac{e}{2}$ (then the assumptions are satisfied for all $e < 4$). We have then $e^* = \dfrac{4}{9}$ (blue line), $e^{AC} = 1$ (red line), $e^{CC} = \dfrac{1}{(2-\lambda)^2}$ (yellow line). Then, for all λ, the concession contract is closer to efficiency than the availability contract.

Figure 3.6: Case where the concession contract is not always optimal.



As for the case where the concession contract is not always optimal, let consider $w(e) = \sqrt{e}$ and $q(e) = \dfrac{e^2}{2}$. We can see that for smaller values of λ, the concession contract is farther from the first-best than the availability contract. In particular, the λ^* that makes the two contractual forms equally inefficient is approximately 0.355569.

In addition, these figures illustrate the fact that there is a range of values of λ around 1 where the contract in which the private provider bears the demand risk is always closer to the first best than the contract in which the private provider does not bear the demand risk.

In sum, we have shown that *it is always optimal to impose the demand risk on the private provider regarding the incentives given to procuring authorities to be accountable.* As for the incentives given to the private provider to reduce costs, there are cases (depending on the impact of the consumers pressure on the private provider's remuneration and on the functional forms for the positive and negative effects of the private provider's cost-cutting efforts) where the contract form such as the concession contract does not dominate the contract form such as the availability contract. In such cases then, a tradeoff occurs between imposing on the private provider the demand risk to raise the accountability and responsiveness of procuring authorities to consumers concerns, and not imposing on the private provider the demand risk to raise its cost-cutting incentives. Otherwise, when the conditions for such cases are not satisfied, the model in which the private provider bears the demand risk always dominates the model in which it does not.

4. ENDOGENOUS PRIVATE PROVIDER'S EFFORT

So far, we have neglected PM's potential role in discovering adaptations whereas many studies have highlighted the importance of PM's incentives to invest in the research into innovative approaches to carrying out the service provision (e.g. Hart, Shleifer and Vishny 1997, Besley and Ghatak 2001, Hart 2003, Benett and Iossa 2006).

If we consider that it is not in PM's interest to implement a quality innovation without renegotiating with PA over the split of the surplus generated by such an innovation, *i.e.* if we assume that PM has no private gains from implementing the adaptation, PM's adaptation incentives would not vary with the contractual design structures we analyse.

However, if we now relax the assumption that PM has no private gains from implementing an adaptation, the contractual design may have an impact on PM's adaptation investment incentives.

4.1. Private Provider's Adaptation Effort under an Availability Contract

Under an availability contract, it is straightforward that PM has no incentives to support the cost of adaptation efforts without negotiating with PA over the surplus sharing. This is due to the fact that the remuneration of PM under an availability contract is fixed, provided that PM meets the quality and performance criteria included in the contract, so that PM receives no private gains from implementing the adaptation.

4.2. Private Provider's Adaptation Effort under a Concession Contract

Under a concession contract, if PM invests in adaptation effort j without any negotiation with PA over the surplus generated by such an investment, PM 's payoff is

$t_0 + w(e) - (1-\lambda)q(e) - j$.

If PM does not invest in adaptation effort and then does not adapt the service according to consumers' demand, his payoff is $\lambda[t_0 + w(e) - (1-\lambda)q(e)]$. In fact, in default of adaptation, consumers will switch to alternative adapted provisions whenever possible, which, in the case of a concession contract, will lead to lower profits for PM .

PM 's maximal gain from adaptation is therefore $(1-\lambda)[t_0 + w(e) - (1-\lambda)q(e)] - j$.

Thus, since PM has control rights, it will implement the adaptation whenever it receives private gains from doing so, *i.e.* whenever the following condition is met

$$(1-\lambda)[t_0 + w(e) - (1-\lambda)q(e)] > j \qquad (7)$$

This condition implies that, if the demand shock (e.g. taste shock), reflected by λ, is large (*i.e.* λ tends towards 0) and that the corresponding cost shock, reflected by j, is small (*i.e.* j tends towards 0), then PM will have incentives to support j without any negotiation with PA over the surplus generated by his investment, because it will receive private gains from doing so.

This leads to the following proposition:

Proposition 3. *If* $(1-\lambda)[t_0 + w(e) - (1-\lambda)q(e)] > j$, *i.e. if the demand shock tends to be large and the cost shock of the adaptation tends to be small, then the private provider has more incentives to invest in adaptation efforts under a concession contract than under an availability contract.*

This proposition is consistent with existing evidence on how concession contracts are working. For example, the main private concessionaire of highways in France has implemented a new radio station in order to offer better real-time information to users on the traffic, without renegotiating with the government any toll adaptation. While interviewing this private provider, it admitted that it had incentives to implement the innovation because the cost of the implementation was low and the consequent impact on demand could be large so that it expected private gains from doing so.

This proposition shows that when the private provider bears the demand risk, it can have, under certain conditions, a direct accountability to consumers; that is even if the contract remains between the procuring authority and the private provider, some market accountability is feasible.

4.3. Complementarity and Substitutability in Accountability

The model shows that, under certain conditions, a concession contract increases both PA's accountability and PM's incentives regarding unanticipated service-provision adaptation. The question that is raised now is to know whether these efforts are complementary or substitutes. In fact, it could be useless to speak about political accountability if PM's incentives could be enough to make PM adapt the public service to satisfy the changes in the effective consumers demand.

First, the model shows that when the demand shock of an adaptation is small and the corresponding cost shock is large, PM does not receive any private gains from implementing the adaptation, *i.e.* it will not have any incentives to implement the adaptation unilaterally. In such a case then – which is most often the case, PM and PA will have to renegotiate the contract and a greater PA's accountability increases the probability that the adaptation implemented will please consumers.

Second, even when the conditions that make PM adapt the service unilaterally when it bears the demand risk are satisfied, PA's accountability and PM's incentives can be complementary. As a matter of fact, even if there is no renegotiation over whether to implement the adaptation, since PM will implement the adaptation without any further inducement, PA and PM can communicate over the way to adapt (e.g. over the actual change in consumers preferences) because a better knowledge by PM of the consumers preferences can increase PM's private gains. In such a case, the greater is PA's attentiveness, the more sense it makes for PM to investigate how to satisfy consumers demand. Conversely, the greater PM's efforts, the more PA can gain from investigating consumers concerns and being responsive to them. Thus, some degree of complementarity can be present and hence the model in which the private provider bears the demand risk can even more dominate the model in which it does not bear the demand risk, as highlighted by the following proposition.

Proposition 4. *If political accountability and private public-service provider's efforts in adaptation are complements, then this complementarity raises the benefit from imposing on the private provider the demand risk. It has no effect on e.*

5. DEMAND OR DEFAULT RISK

So far, we have considered that the payments from PA to PM, provided that performance criteria are met, are guaranteed when the private provider does not bear the demand risk. But this absence of "demand risk" under contracts such as the availability contract could be an illusion. As a matter of fact, the payments to PM depend on PA's budget, *i.e.* on the capacity of PA to pay. So we can imagine that in periods of tiny budgets, PA might have some problems to pay PM when the latter does not bear the demand risk[15]. We can expect that the likelihood of such a default risk will be higher in less developed countries than in developed countries. Nevertheless, when procuring authorities are local entities, such a risk can occur whether the country is wealthy or not (e.g. the city of Angoulême in France that went bankrupt in 1991, and was then unable to honour any of its commitments) (Gilbert and Guengant 2002).

So let consider now the possibility of a default risk when the private provider does not bear the demand risk. In particular, we use the parameter γ to capture the probability of the absence of procuring authorities' default risk, with $\gamma \in [0,1]$[16]. While this parameter might affect PM's cost-reducing incentives, *it will not have any impact on the political accountability.* Therefore, repeating the exercise of the section 3 and focusing on PM's cost-reducing incentives under an availability, PA and PM's overall payoffs from Z are:

$$u_{PA} = b - \gamma(t_0 + t) - q(e) + v(i) - i$$

[15] We consider in this section that when the private provider bears the demand risk, its payments do not depend on the procuring authority's budgets (it means that we exclude from the analysis the shadow toll contracts).

[16] Thus, when $\gamma = 1$, it means that the likelihood of procuring authorities' default risk is equal to zero and, conversely, when $\gamma = 0$, the likelihood of default risk is equal to one.

$$u_{PM} = \gamma(t_0 + t + w(e)) - e$$

PA's default payoff is then $b - \gamma t_0 - q(e) + (1-k)v(i)$

PM's default payoff is $\gamma(t_0 + w(e))$

PA's maximal gain from renegotiation is therefore $kv(i)$.

PA and PM's renegotiation gains are ½ of this sum. So PM chooses e to maximise

$$\gamma(t_0 + w(e)) + \frac{1}{2}\left[kv(i)\right] - e \qquad (8)$$

The first-order conditions is now

$$\gamma * w'(e) = 1 \qquad (9)$$

The above first-order condition demonstrates how an availability contract decreases PM's cost-cutting incentives compared to a concession contract when $\gamma \leq \frac{1}{2}$. As a matter of fact, the model shows that for γ equal to $\frac{1}{2}$, PM's cost-cutting incentives under an availability contract are equivalent to the ones under a concession contract for $\lambda = 0$ and under-optimal. However, when γ tends towards 0, PM's cost-cutting incentives under an availability contract tend to be smaller than under a concession contract, since the effort of the private provider under an availability contract is increasing in γ. So we need λ* to increase so as to rebalance the two contractual forms. As this process continues and γ gets small, λ* gets high, and hence the concession contract tends to be more often optimal.

When $\gamma \in [\frac{1}{2}, 1[$, the efforts under a concession contract can be superior or inferior than the efforts under an availability contract. More specifically, the concession contract will be more optimal for intermediate range of values of λ, whereas for extreme values the availability contract will be more optimal.

This leads us to the following proposition:

Proposition 5. *For $\gamma \leq \frac{1}{2}$, as the likelihood of default risk of public authorities gets high, i.e. γ gets small, λ^* is weakly increasing,* i.e. *the contract in which the private provider bears the demand risk tends to be more often optimal.*

In addition, increasing the likelihood of PA's default risk, i.e. *a smaller γ, decreases PM's incentives to invest in cost-reducing efforts.*

Proof. See Appendix 3.1.

Intuitively, if the private provider bears the risk of default of the procuring authority, it may not be able to internalize the positive effect of e. More precisely, the higher the likelihood of default of the procuring authority, the less PM will internalize the positive effect and then the smaller e; conversely, the lower the likelihood of default of the procuring authority, the greater the internalisation by the private provider of the cost savings of its cost reducing investments and hence the higher his cost reducing efforts. PM's efforts are then increasing in γ.

In sum, considering the potentiality of default of procuring authorities tends to make the concession contract be more often optimal than the availability contract, under certain conditions, regarding the cost-cutting incentives of the private provider. This might explain why we do not observe as many availability contracts in less developed countries as in developed countries, since the default risk of procuring authorities in such countries can be very high (γ tends towards zero). However, as already highlighted, such a default risk can also occur in developed countries (e.g. when the procuring authority is a local entity) but the probability of occurrence is lower than in less developed countries.

6. DISCUSSION

Overall, the model highlights that contracts in which the private provider does not bear the demand risk, even though they permit to reduce the likelihood of renegotiation, are not always optimal. In other words, we have pointed out that there is a tradeoff between using concession contracts to raise private providers' and public authorities' incentives to be responsive to consumers concerns, and resorting to availability contracts to limit the likelihood of renegotiation. Thus, this tradeoff will mainly depend on the following criteria: (a) the possibility for consumers to exercise pressure on private providers' revenue, (b) the default risk, and (c) the likelihood of renegotiation.

Taking into account these three criteria, it is possible to make some predictions on the contractual form that would best fit a particular sector.

6.1. Speculation

Let first consider the case of water supply. In such a case, the availability of alternative provisions for consumers is rather limited (they can however still buy bottles of water) (Ménard and Saussier 2002 and 2003). Thus, procuring authorities cannot credibly threaten the incumbent private provider in side-trading it in case of default of adaptation of the service provision. Are availability contracts then better suited to this sector? The tradeoff will depend on the likelihood of renegotiation *versus* the likelihood of default of the procuring authority.

For road projects, consumers have most often the choice between alternative provisions (e.g. trains, alternative roads), so that the impact of the consumers' pressure on the private provider's remuneration can be significant[17]. Concession contracts will therefore dominate availability contracts regarding the allocative efficiency. However, the quality of roads is largely contractible, so that we can expect a very low effect of cost-reducing investments on quality. The model highlights that when there is no effect of cost-reducing investments on quality, availability contracts always dominate concession contracts regarding the incentives of the private provider to cut costs. In addition, as already stressed, the uncertainty associated with future traffic is very high and exogenous, making toll road concessions particularly prone to renegotiation issues. A clear prediction in this sector is therefore not possible, but will tend to favour the use of availability contracts in this sector.

By contrast, we can expect that contracts in which the private provider bears the demand risk will be more suitable for the management of schools (included school catering services) and hospitals where there is a diversity of provisions and a low uncertainty on the future demand.

These results are generally consistent with existing evidence on how PFI is working, compared to concession contracts. According to a report commissioned by the Treasury Taskforce (Arthur and Andersen and Enterprise LSE 2000), PFI appears to have worked well for roads, generating substantial cost saving, though it has worked less well for schools and hospitals.

[17] Again, and particularly in the road sector, a marginal variation in the demand can be sufficient to generate negative profits for the private provider.

6.2. A Continuum Choice of Contracts Rather Than Binary

As highlighted in the second chapter, it is contractually possible to restrict the demand risk imposed on the private provider within a concession contract, so that public authorities do not face a binary choice of contracts but a continuum choice.

However, this does not question the results we obtained to the extent that the weaker the extent to which the private provider bears the demand risk, the weaker the potential impact of the consumers' pressure on its remuneration, *i.e.* the higher the λ, and hence the weaker the advantages to resort to concession contracts, everything else being equal.

6.3. Voucher Provision, Transaction Costs and Political Accountability

The model developed in this chapter underpins the standard argument for voucher provision of public services. The state provides the citizens with a voucher that entitles the individual to a particular service (or it could be a monetary amount) and they then choose where to spend that voucher. A better matching between consumers and providers is therefore reached. This attenuates incentive problems and increases organizational efficiency by economizing on the need for explicit incentives. This can explain why the transaction costs of designing a contract in which the private provider bears the demand risk are much lower than those associated with the design of a contract in which the private provider does not bear the demand risk.

This chapter also addresses the broader question of how to increase the political accountability and more specifically if it is possible to increase the political accountability by empowering the consumers, *i.e.* by allowing them to oust a firm when this one bears the demand risk. We show that, in the particular case we analyse, the political accountability is higher when consumers are empowered.

6.4. Comparison with the Public Provision

While Ellman (2006) finds that it is always optimal to have in-house provision relative to contracting out provision regarding the political and public accountability, we show that under some conditions, the contracting-out model in which the private provider bears the demand risk might dominate the public provision since it allows political accountability as well as cost-reducing investments.

7. CONCLUSION

Traffic forecasts are notoriously imprecise. This fact, combined with informational asymmetries, implies the prevalence of a strong winner's curse effect in toll road concession settings, which we have tested and confirmed in the first chapter. This fact also worsens the incompleteness of toll road concessions and makes opportunistic renegotiations become more likely, which encourages lowballing, also highlighted in the first chapter. One way to reduce these problems caused by contract incompleteness is to design contracts that do not impose the demand risk on private providers. The fact is that governments around the world have recently promulgated guidelines so as to bring in availability contracts as an alternative to concession contracts.

However, in this chapter, we have shown that such contracts can on the other hand generate other inefficiencies, to which literatures have paid very little attention: *weaker political accountability*.

Indeed, we have developed a model of the choice between availability and concession contracts that gives an active role to public authorities. Thus, not only private providers, but also public authorities, can be expropriated *ex post* of a part of the surplus generated by their efforts to investigate and satisfy consumers' changing demand. We have analysed the effects of the contractual design – concession contract *versus* availability contract – on the incentives of private providers *and* procuring authorities to be responsive to consumers. The model shows that the contract form in which the private provider bears the demand risk always dominates the one in which it does not bear the demand risk regarding the incentives given to procuring authorities and private providers to be responsive to consumers concerns.

As for the incentives of the private provider to reduce costs, there are cases (depending on the impact of consumers' pressure on the private provider's remuneration and on the functional forms of the positive and negative effects of the private provider's cost-cutting efforts) where the contract form such as the concession contract does not dominate the contract form such as the availability contract. In such cases then, a tradeoff occurs between imposing the demand risk on the private provider to raise the accountability of procuring authorities, and not imposing the demand risk on the private provider to raise his cost-cutting incentives. Considering the potentiality of default of procuring authorities tends to make the concession contract be more often optimal than the availability contract, under certain conditions, regarding the cost-cutting incentives of the private provider.

An application of our model to the road sector would tend to advocate the dominance of availability contracts over concession contracts, but it will depend on the possibility to forecast future traffic with accuracy.

We intend to further investigate the issue of political accountability by laying more emphasis on the role of consumers, by giving a more active role to consumers. In particular, in our model, we consider that consumers' and public authorities' benefits from adaptation are proportional. It could be however interesting to analyse what happens when public authorities are not an interface that always reflect consumers' preferences.

Our model has also a black-box feature: λ. In particular, we have made a ad hoc assumption about sanctioning behaviour of consumers. It could be however interesting to open up this black box and further analyse how consumers behave when they are not satisfied by a public-service provision.

Appendix 3.1: Proofs of the Propositions

A. Proof of Proposition 1

The first-order condition when the private provider bears the demand risk is

$v'(i) = \dfrac{2}{2-\lambda k}$, or, equivalently, $(2-\lambda k)v'(i(\lambda)) = 2$.

Taking the derivative with respect to λ yields $(2-\lambda k)v''(i(\lambda))i'(\lambda) - kv'(i(\lambda)) = 0$

Rearranging and solving for $i'(\lambda)$:

$$i'(\lambda) = \frac{kv'(i(\lambda))}{(2-\lambda k)v''(i(\lambda))}$$

Since v is concave as well as $0 \le \lambda \le 1$ and $0 < k \le 1$, the denominator is always negative and the numerator is always positive. Therefore, $i'(\lambda)$ is always negative.

B. Proof of Proposition 2

B.1. Proof of proposition 2 ii)

The first-order condition when the private provider bears the demand risk is

$$w'(e) - q'(e)\left[\frac{2\lambda(1-\lambda)}{(\lambda+1)}\right] = \frac{2}{\lambda+1}$$

or, equivalently, $(\lambda+1)w'(e(\lambda)) - (2\lambda(1-\lambda)q'(e(\lambda)) = 2$.

Taking the derivative with respect to λ yields

$(\lambda+1)w''(e(\lambda))e'(\lambda) + w'(e(\lambda)) - (2\lambda(1-\lambda)q''(e(\lambda))e'(\lambda) - (2-4\lambda)q'(e(\lambda)) = 0$.

Rearranging and solving for $e'(\lambda)$:

$$e'(\lambda) = \frac{(2-4\lambda)q'(e(\lambda)) - w'(e(\lambda))}{(\lambda+1)w''(e(\lambda)) - 2\lambda(1-\lambda)q''(e(\lambda))}$$

Since w is concave and q is convex (as well as $0 \le \lambda \le 1$), the denominator is always negative. Since $w' - q'$ is always positive, the numerator is also always negative for $\lambda > \frac{1}{4}$. Therefore, when $\lambda > \frac{1}{4}$, $e'(\lambda)$ is always positive.

C. Proof of Proposition 5

The first-order condition is

$$\gamma w'(e(\gamma)) = 1$$

Taking the derivative with respect to γ yields

$$\gamma w''(e(\gamma))e'(\gamma) + w'(e(\gamma)) = 0$$

Rearranging and solving for $e'(\gamma)$:

$$e'(\gamma) = -\frac{w'(e(\gamma))}{\gamma w''(e(\gamma))}$$

Since w is concave, the denominator and the numerator are also always negative. Therefore, $e'(\gamma)$ is always positive.

GENERAL CONCLUSION

Reforming public-service delivery occupies a central position in the current policy agenda in the world. The World Development Report of 2004 had public service delivery as a headline issue. Public private partnerships, which are contracts between public and private sector to build and operate infrastructure for public-service provision, are considered as an alternative model to the traditional public provision for public services. Being a hybrid arrangement, PPPs may in fact dominate both fully public and private provisions by inducing cost minimization behaviour by the private provider in charge of the provision while reducing potential market failures by limiting the market power conferred on the private provider *via* the regulation through the contract. In other words, they may avoid substituting market failures with public failures. The fact is that they are now worldwide used for a wide range of public services.

However, it is now possible to draw some lessons on the worldwide experience, and the record is quite mixed. Most often, PPPs are not meeting the expectations that they suggested. In particular, specifying complete contracts for public-service provision may be costly or impossible, leading to the need for public authorities and private providers to renegotiate the initial contract. This may provide room for *ex post* opportunistic behaviour from contracting parties, since they are *ex post* engaged in a long-term, bilateral relationship, and hence lead to many inefficiencies (Williamson 1985). Most prominent among them are the lowballing of bidders in the expectation of renegotiation, and the inefficient development of PPPs over time.

This dissertation sought to shed some theoretical and empirical insights into the black-box of PPPs with a more detailed account of these criticisms, while focusing on the major type of PPP: toll road concessions.

To assess the prevalence and importance of uncertainty, informational asymmetries and dispersion, and renegotiation in toll road concessions, we have empirically tested their effects on bidding behaviour. If uncertainty, informational asymmetries and dispersion, and renegotiation really characterize such contracts, we should observe during the auctions for such contracts, first, an overall winner's curse effect, second, a stronger winner's curse effect in auctions with a greater degree of common uncertainty, and third, a weaker winner's curse effect in auctions with a higher likelihood of renegotiation, suggesting lowballing bidding behaviour. We were able to approximate the bidding behaviour of private providers by comparing traffic forecasts included in the winning bids with the actual traffic. This approach has permitted us to point out that, *in fact*, uncertainty, informational asymmetries and dispersion, and renegotiation are important issues associated with toll road concession contracts, since we do observe the three effects mentioned above with significance.

Uncertainty and renegotiation issues can however be tackled by adapting the contractual design of toll road concessions accordingly. We have then analysed theoretically and empirically the tradeoffs at stake between contractual flexibility and rigidity. In contrast with previous studies that analyse the distorted incentives to innovate of the private provider according to various ownership structures, we think that private providers' incentives may also vary with the contractual design. We have then developed a refined incomplete contract theory model with maladaptation and renegotiation costs. The model explains why high uncertainty, weak trust between the contracting parties, or a lack of a strong institutional environment would lead to the design of more rigid contracts. Using original data self-gathered from a variety of sources on the design of toll adjustment provisions, projects and contracting parties characteristics, and institutional frameworks, we have shown that the theoretical predictions of our model fit the empirical findings. We have therefore pointed out that contracting parties *do* design their contractual relationship according to the importance of renegotiation and uncertainty issues.

While the adoption of other types of PPP, in particular of public private contracts in which private providers do not bear the demand risk, can constitute another way to deal with uncertainty and renegotiation issues, and in particular with the lowballing bidding behaviour we have highlighted, it can on the other hand generate other inefficiencies, to which literatures have paid very little attention: weaker political accountability. Indeed, public authorities have an important role to play in the adaptation of private public-service provision over time, first and foremost because, as elected delegates of consumers, they have to account for, and satisfy, consumers' changing demands. Thus, whereas the literature has so far focused on the potential hold-up by public authorities from a part of the surplus generated by private providers' investments, it seems also crucial to pay attention to the expropriation by private providers, in turn, of a part of the surplus generated by public authorities' efforts to be responsive to consumers. We have shown that the contractual design of PPPs can impact these efforts. More specifically, we have emphasized that there is a lower matching with consumers' preferences over time when private providers do not bear the demand risk than when they do. More precisely, contracts in which private providers do not bear the demand risk rule more out the accountability – regarding service adaptations – of public authorities *and* private providers to individual consumers. We have hence demonstrated that empowering consumers can strengthen incentives for governments to be responsive.

We contemplate nevertheless investigating further these issues. It seems in fact important to take into account dynamic concerns in toll road concession auction settings for the following reasons. First, even in a stationary environment, dynamic considerations arise if firms engage in collusion. Even though, the occurrence of collusion is not obvious in such auctions, it might be worth considering it. Second, the underlying distribution of valuations might change as a function of auction outcomes, potentially in ways that are observable (or can be directly inferred) by the other bidders. For example, bidders may have capacity constraints (or more general forms of diseconomies of scale). In that case, a bidder that wins an auction today might draw a valuation from a less favourable distribution in the future.

It could also be interesting to analyse whether a misalignment between the contractual design predicted by our model and the observed contractual design translates in weaker performance. In particular, are misaligned contracts more prone to renegotiations? In addition, as the literature has shown that the efficiency of contractual choices also depends on the way private providers are selected, it seems important to analyse whether flexible contracts, that rely more on trust and relational dimensions, are attributed through auctions with more subjective awarding criteria. This suggests that further research on the articulation of both *ex ante* and *ex post* dimensions of an auctioned public private contract is necessary.

We also intend to further investigate the issue of political accountability by laying more emphasis on the role of consumers. In particular, in our model, we consider that consumers' and public authorities' benefits from adaptation are proportional. It could be however interesting to account for potential misalignments between consumers and public authorities interests and then to analyse more specifically the relationships between consumers and public authorities by giving a more active role to consumers.

This dissertation leads to several striking policy implications. One of them concerns the optimal number of bidders during auctions for toll road concessions. Specifically, we show on the one hand that there is a strong winner's curse effect in toll road concessions that implies less aggressive bidding behaviour as competition gets fiercer. On the other hand, we show that there is a quite systematic traffic overestimation due to methodological and behavioural sources. This implies that in most cases bidders will experience very low or negative profit rates, which leads them to pressurize public authorities to renegotiate *ex post* the contractual terms. Thus, the winner's curse effect can compensate for the systematic traffic overestimation and result, in the long-term, in a weaker occurrence of renegotiation. As a consequence, the policy implications that follow from our results will depend on whether public authorities are myopic. We can infer that myopic public authorities may wish to restrict the number of bidders, or favour negotiations over auctions, so as to reduce the winner's curse effect and then encourage more aggressive bidding behaviour. Conversely, non myopic public authorities, *i.e.* public authorities that weight more long-run gains than short-run ones, will consider the long-run consequences of more aggressive bids and may then prefer to maintain the awarding procedure as open as possible. The same reasoning applies for the policy implication regarding the public release of traffic forecasts prior to bidding. While, myopic procuring authorities, interested in reducing the winner's curse effect, may consider releasing contract information that reduces information dispersion in toll road auctions, non myopic public authorities may prefer not to consider it.

Other policy implications deal with how public authorities should design their contracts with private public-service providers according to the degree of uncertainty and asset specificity, the contracting parties' characteristics – in particular their propensity to renegotiate contractual terms –, and institutional frameworks. In this respect, we have pointed out that flexible contracts are more likely to be preferred (a) the higher the uncertainty; (b) the lower the degree of investment specificity; (c) the lower the proclivity of contracting parties to enter in conflicts, haggling and friction.

Final striking policy implication of this dissertation: the trend towards a greater resort by public authorities to availability contracts, or more generally to contracts in which private providers do not bear the demand risk, instead of concession contracts so as to reduce the occurrence of renegotiation and hence lowballing bidding behaviour, may be not optimal, especially regarding allocative efficiency.

More generally, the discussion conducted throughout this dissertation makes us realize the importance of not only formal, but also, and maybe above all, informal institutional settings. For instance, in the first chapter, our empirical work points out the necessity of adopting a more global perspective when considering bidding behaviour during auctions for public private partnerships. In particular, *ex post* extra contractual dimensions of a contractual relationship between private providers and public authorities should be taken into account. We also show that political considerations as well as trust impact the choices of contractual design. Finally, we point out that if PPPs formally involve only public authorities and private providers, the public may also have an important role to play – though informal – to foster the efficiency of this particular organisational form of the provision of public services. Empirical and theoretical works focusing only on the contractual/formal dimensions of PPPs may lead to miss out some important aspects of how components of PPPs interact and communicate to determine their efficiency.

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