Contractual Design of Toll Adjustment Processes In Infrastructure Concession Contracts: What Matters?[1]

Laure Athias[2]
ATOM – U. of Paris Sorbonne
112 bd. De l'Hôpital, 75013 Paris
athias.laure@wanadoo.fr

Stéphane Saussier
ADIS – U. of Paris 11 & ATOM – U. of Paris Sorbonne
112 bd. De l'Hôpital, 75013 Paris
saussier@univ-paris1.fr

December 2005

Abstract: In this article, we explore the contractual design of toll infrastructure concession contracts. We highlight the fact that the contracting parties do not only try to sign complete rigid contracts in order to avoid renegotiations but also flexible contracts in order to adapt contractual framework to unanticipated contingencies and to create incentives for cooperative behavior. This gives rise to multiple toll adjustment provisions and to a tradeoff between rigid and flexible contracts. Such tradeoff is formalized with an incomplete contract framework – including *ex post* maladaptation and renegotiation costs – and propositions are tested using an original database of 71 concession contracts. Results show that 1/contractual choices are not randomly made and 2/ the reputation of concessionaires is most often not taken into account. In this perspective, our work complements other empirical studies on contractual price provisions (Bajari-Tadelis 2001, Masten-Crocker 1991, Crocker-Reynolds 1993), by considering the case of public-private contracting, as well as other studies on public-private partnerships, by focusing on toll adjustment provisions and documenting the effect of reputation.

JEL codes: D23, D82, H11, H54, L9, L14, L24.
Keywords: Contractual design, concession contract, toll adjustment processes, incomplete contracting.

[1] We gratefully acknowledge comments and suggestions from Sandro Cabral, Armelle Mazé, Pierre Garrouste, Mar Rubio, Dean Williamson and participants at the 9th ISNIE Conference organized by University of Pompeu Fabra, the 4th Conference on Applied Infrastructure Research organized by the WIP center, Berlin University of Technology and the ATOM seminar.
[2] Corresponding author.

0. Introduction

The "infrastructure gap" in Europe has 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. However, governments have limited financial resources to devote to increased capital expenditure and improving public services, and they face restrictions (including those of the Maastricht Treaty) on their ability to raise debt. In order to bridge the gap between the cost of the infrastructure needed and the resources available, and to ensure that the infrastructure is delivered as efficiently and cost-effectively as possible, Public-Private Partnerships (PPPs) are seen as one solution. The defining feature of a PPP is that the government buys services whereas in a conventional arrangement the government buys or builds a physical asset. 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). Nevertheless, even in the UK where there is significant resort to PPPs, 85% of public investment is delivered through conventional forms of procurement (HM Treasury 2003). This limited recourse may be explained by significant transaction costs that may arise in such public private contracts. Indeed, PPPs are long-term partnerships between the public and private sectors that usually evolve in an uncertain environment and involve a high level of specific investments; three features that make such contracts difficult to design in order to protect investors and promote adaptation of the contractual relationship at the same time (Williamson 1976, Crocker-Masten 1991, Saussier 2000). Bad contractual design, especially concerning the way price should evolve *ex post,* may generate high levels of transaction costs and hence make traditional procurement more efficient than PPPs.

In this paper, we examine the processes by which parties adjust prices – tolls – in toll road concession contracts (highways, bridges, channels). 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. That such contracts often contain provisions for the periodic adjustment of tolls is not surprising. Both relative prices and the general price level can change substantially over the extended time periods covered by many contracts, making original prices inappropriate to future conditions. What is more surprising is the great variety of processes that contracting parties have devised to effect such adjustments. Toll adjustment provisions vary from "firm-fixed price" provisions that permit no toll adjustment at all to renegotiation provisions, which consist in determining *ex ante* periodic *ex post* negotiations of the initial adjustment process. But while there have been some empirical studies of how the contracting parties choose among alternative pricing processes in private commercial contracts or in procurement contracts (Bajari-Tadelis 2001, Masten-Crocker 1991, Crocker-Reynolds 1993), there has been, to our knowledge, no such analysis in toll infrastructure concession contracts whereas these contracts are special agreements in numerous ways. First, they are very long-term contracts (often over 30 years) involving a degree of uncertainty that is much greater than in most ordinary contracts. Indeed, forecasting errors and associated risks are characteristics of infrastructure projects. Studies of such errors (Pickrell 1990; Flyvbjerg 1997, 2002, 2003; Odeck 2004) show that construction costs are generally underestimated and traffic overestimated, by large amounts. Errors of 50% or more seem to be the rule rather than the exception. Second, the likelihood of opportunism in concession contracts is not any more to be proved. The related literature to concession contracts, empirical (Estache 2004, Bajari and al. 2004, Gomez-Ibanez and Meyer 1993, Engel 2003, Guasch 2004) as well as theoretical (Williamson 1976), points out that these contracts between a public authority and a private entity are particularly pervasive renegotiations prone. Third, and finally, the stakes involved in toll adjustment provisions are huge. Indeed, on the one hand, in most concession contracts, tolls are the sole source of income for concessionaires. The way they will be adjusted for the whole length of a concession will therefore impact on concessionaires revenue and hence on their risk-taking. But, on the other hand, toll adjustment provisions restrain the monopoly power that concessionaires may exercise *ex post,* by determining *ex ante* the tolls that can be charged to infrastructure users *ex post*. The necessity to shape efficient toll adjustment processes is therefore crucial.

In order to highlight tradeoffs in such contract design, we develop a model mixing transaction cost theory and incomplete contract theory (Hart 1995). We argue it is of great importance 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. This problem begins to be studied for Less Developed Countries (Guasch 2004, Guasch-Laffont-Straub 2003 and 2005, Laffont 2005) and clearly contributes to the inefficiency of PPPs. Such renegotiations also exist in developed countries. Our data illustrate this. We therefore consider in our model the likelihood of contractual renegotiation as an independent dimension, not completely connected to the design of the contract that is signed. 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 (Bajari-Tadelis 2001, Masten-Crocker 1991, Crocker-Reynolds 1993). 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). Besides, contrary to the incomplete contract theory view, we consider that renegotiation is costly and that maladaptation costs might exist. Our model leads us to several propositions identifying crucial elements in the understanding of the choice of the toll adjustment process. Those elements are the uncertainty surrounding the project, the complexity of the project and the contracting parties reputation.

To test our propositions, we have constructed an original database consisting of 71 worldwide toll road concession contracts. Our econometric results indicate first a strong correlation between traffic uncertainty and the type of toll adjustment chosen, as predicted by the model. Second, they also suggest very low, not to say none, effects of concessionaires reputation (measured in several different ways) on the choice of the toll adjustment provision. This runs counter to previous empirical studies that document the effect of reputation on the choice of contracts (Crocker-Reynolds 1993, Banerjee-Duflo 2000) and to many recent studies (Doni 2005, Bajari-McMillan-Tadelis 2003, Schugart 2005) that insist on the fact that reputation particularly matters in PPPs. Third, our results highlight a trend towards more rigidity in contracts that is not justified by an evolution of the characteristics of the projects or of the concessionaires. These results might reflect a political will to limit as much as possible renegotiation and therefore to constrain concessionaires opportunism.

Thus, the contribution of our article is twofold. First, at the theoretical level, by proposing an incomplete contract theory model with renegotiation and maladaptation costs and hence by making propositions on the design of price provisions in contracts in a formalized way, in contrast to the previous papers on this topic (Masten-Crocker 1991, Crocker-Reynolds 1993). Second, at the empirical level, by focusing on concession contracts and toll adjustment provisions, both never addressed before, with unique panel data.

The article 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. In Section 3, we describe the contractual toll adjustment processes observed in our sample of contracts and in Section 4, we present the original panel data used in the empirical section. Section 5 contains the econometric results, and a final section provides concluding remarks.

1. Economic Tradeoffs in Contract Design of Public-Private Contracts

In order to develop their infrastructure, public authorities (States or local authorities) may decide to resort to traditional procurement contracts or to PPPs. The key contrast between PPPs and traditional procurement is that under PPPs the private sector delivers over the contract length services, not assets, although providing assets is often integral to the services. They are therefore not only responsible for asset delivery, but also for overall project management and implementation, and successful operations for several years thereafter. Thus, PPPs are complex long-term agreements, involving non verifiable investments[3], usually for delivering complex services or at least services in which uncertainty is high. As emphasized by Doni (2005), the context of public-private contracts is frequently characterized by imperfect verifiability of the services. We are thinking, for example, of how difficult 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.

Such characteristics of the transaction impede the crafting of complete contracts and hence induce incomplete contracting (Hart 1995). These investments may result in higher profits or

[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 his 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.

better service quality delivered by the private operator. In this paper, we focus on concession contracts in which the private operator has residual rights of control over the way the service is provided. We suppose that, after the initial contract has been agreed, the provider may 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 paper focuses attention on two different kinds of transaction cost: maladaptation costs due to the complexity of the transaction, the uncertainty of the environment and the bounded rationality of the contracting parties, 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 (Guasch 2004, Engel and al. 2002, 2003 and 2005, Estache 2004, Bajari and al. 2004, Gomez-Ibanez and Meyer 1993). But, in contrast to the previous literature on this topic (Bajari-Tadelis 2001, Masten-Crocker 1991, Crocker-Reynolds 1993), 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 more complete than a contract in which contracting parties do not have this goal. This is the reason why we do not speak about contractual completeness but about contractual rigidity. In fact, there are two main reasons for a rigid contract to be renegotiated. First, as illustrated by the literature, rigid contracts might be renegotiated for efficiency considerations.

When the contracting parties reach the point where an inefficient outcome is suggested by the contract, they can always tear up the initial contract and write a new Pareto-improving contract. As a result, when the contracting parties are unable to commit not to renegotiate they will have to abandon these contracts designed to be executed without renegotiation. Second, rigid contracts might be renegotiated even though they are adapted to states of nature. In this case, renegotiation is more seen as a political decision than a way to avoid maladaptation costs of a rigid contract. Lobbying from private operators (Guasch 2004) or specific political context (Tirole 1999, Jolls 1997, Engel 2005) might be some cases of political renegotiation.

Thus, to take into account those specificities, we propose to disconnect the question of renegotiation from the one of contractual choices by considering the potential for contract renegotiation as an exogenous parameter. We highlight tradeoffs at stake in the contractual design of toll adjustment provisions in the following model.

2. The Model

This section develops a reduced form model of contractual choices based on incomplete contract theory (Hart, 1995).

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. [4]

A part of investments required by the private investors are non verifiable (not necessarily specific). Thus we make the assumption that it would be impossible or too costly for the State

[4] To simplify, we only consider the case where the private contractor is the only one to invest. This is coherent with what we observe in many PPPs. This is also what is considered by Hart (2003).

or a third party to check investments made by the private operator (see Part 1 of this paper for a discussion on this topic). We note these investments *i*. These investments generate a surplus noted *R(i)*. We make the classical assumption that $R'>0$ 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 states of nature. In other words, in such a contract, the parties try to prevent *ex post* 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 *ex post* renegotiation and plan to renegotiate price once uncertainty unfolds.

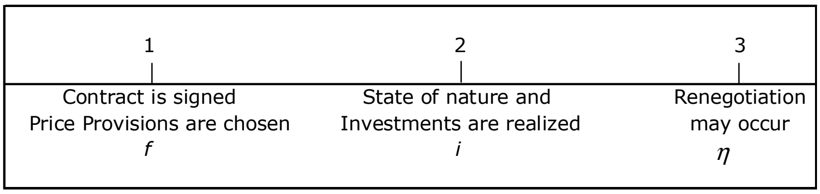
We note $f \in]0,1]$, where $\underline{f}$ ($\overline{f}$) represents the impact on the *ex post* surplus of a rigid (flexible) contract. Thus we make the assumption that the *ex post* realized surplus of the transaction is a function not only of the investments but also of the design of the contract. Depending on the kind of contract that is signed, the repartition of the surplus (rigid contract) or the repartition and the total surplus (flexible contract) will be a function of the adequacy of the contract to states of nature. In fact, a rigid contract generates maladaptation costs without any loss of global surplus, whereas a flexible contract generates renegotiation costs with a loss of global surplus[5].

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 $r(i) = \alpha . R(i)$ with α the level of investment specificity. When $\alpha \rightarrow 0$ then investments made by the private operator do not generate any surplus when used outside of the contract relationship. Investments are therefore totally specific.

[5] This does not imply that rigid contracts are always to be preferred to flexible ones because the global surplus is also a function of investments realized by private operators.

The timing of the model is classic.

Figure 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

$$S = Bo - Co + R(i) - i$$

Where Bo and Co are positive constants and respectively the social benefit and cost of providing the basic service.

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

$$i^* / R'(i^*) = 1 \qquad (1)$$

Flexible Contracting

When parties decide to sign a flexible contract, they accept the fact that they will have to renegotiate the contract 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 is shared between the parties through a Nash solution.

Private operator's objective function is profit π_c, where

$$\pi_c = P_0 - Co + ½ [\overline{f} R(i)+r(i)] - i \qquad (2)$$

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

$$i^f / R'(i^f) = 2/(\overline{f} + \alpha) \qquad (3)$$

Consumer surplus is then given by *CS*, where

$$CS = B_0 - P_0 + ½ [\overline{f} R(i^f) - r(i^f)]$$

Government's objective function is social surplus *S*, which is the sum of consumer surplus and the profit of the private operator. Thus, we have

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

Rigid Contracting and Parties Can Commit not to Renegotiate

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

$$\pi_c = P_0 - C_0 + \underline{f} R(i) - i \qquad (4)$$

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:

$$i^r / R'(i^r) = 1/\underline{f} \qquad (5)$$

Consumer surplus is then given by *CS*, where

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

The *ex post* maladaptation of the contract results in the recovery of a part of the surplus, generated by private operator's investments, by consumers.

The total surplus is then given by *S*, with

$$S = B_0 - Co + R(i^r) - i^r$$

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.

Rigid Contracting and Parties Cannot Commit not to Renegotiate

Nevertheless, as discussed in the first part, 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 *ex post*, the profit generated by such contract for the private contractor is given by

$$\pi_c = \eta\left[P_0 - C_0 + \underline{f}.R(i) - i\right] + (1-\eta)\left[P_0 - C_0 + \frac{1}{2}\left[\overline{f}.R(i) + r(i)\right] - i\right] \quad (6)$$

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

$$i^{rr} / R'(i^{rr}) = \frac{2}{\alpha + \overline{f} + \eta(2\underline{f} - \alpha - \overline{f})} \quad (7)$$

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 5 and 7 are the same).

Consumer surplus is then given by

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

It follows that

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

2.3. Comparisons

As discussed in the first part, we do not consider the case of rigid contracting without any *ex post* renegotiation as a plausible one. Thus, in this part, 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 global surplus under the two types of contracting.

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

$$B_0 - Co + \overline{f}R(i^f) - i^f < B_0 - Co + (1-\eta)\overline{f}R(i^{rr}) + \eta R(i^{rr}) - i^{rr} \qquad (8)$$

which leads to the following condition

$$\overline{f}R(i^f) - i^f < \overline{f}R(i^{rr}) - i^{rr} + \eta \underbrace{\left[R(i^{rr}) - \overline{f}R(i^{rr})\right]}_{\text{deadweight loss of surplus due to renegotiation}} \qquad (9)$$

It is straightforward to see that the higher the renegotiation costs ($\overline{f} \rightarrow 0$) and the lower the likelihood of contract renegotiation ($\eta \rightarrow 1$), the more efficient is a rigid contract compared to a flexible one. Besides, it follows from (9) that the conditions under which a rigid contract generates more investments than a flexible one also lead to a higher global surplus. Thus, the question of the efficiency of rigid *vs*. flexible toll adjustment provisions comes down to the comparison of i^f and i^{rr}.

Contractual Choices and Investment Levels

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. This is explained by the fact that the operator anticipates that he will have to let a part of the surplus generated by his investments to the State when the renegotiation occurs ($i^f \leq i^*$).

If we now look at the choice of contract type when the contracting parties cannot commit not to renegotiate, it is driven by the comparison of investment levels that ensue from equations (3) and (7). The necessary conditions for a rigid contract to be preferred to a flexible one are:

$$i^{rr} > i^f \Leftrightarrow \eta(2\underline{f} - \alpha - \overline{f}) \succ 0 \Leftrightarrow \eta > 0 \text{ and } (2\underline{f} - \overline{f}) > \alpha \qquad (10)$$

In other words, 1/ the lower the likelihood of contract renegotiation (*i.e.* $\eta \to 1$), 2/ the higher the degree of investment specificity (*i.e.* $\alpha \to 0$), 3/ the more it is possible to specify *ex ante* a rigid contract that will be efficient *ex post* (*i.e.* $\underline{f} \to 1$), 4/ the more difficult the *ex post* adaptation in a flexible contract (*i.e.* $\overline{f} \to 0$), then the more efficient a rigid contract compared to a flexible one.

This leads us to the following testable propositions. Our results highlight the need for the contracting parties to be to a certain extent credible when they commit not to renegotiate the contract.

Proposition 1: The lower the likelihood of contract renegotiation, the more rigid contracts should be.

Our results also point out the impact of specific investments on contractual choices.

Proposition 2: The higher the degree of investments specificity, the more rigid contracts should be.

This result is explained by the fact that a rigid contract ensures the private operator the share of the surplus generated by his investments, in contrast to a flexible contract in which renegotiation splits the surplus between the parties.

Furthermore, the above comparison between the efficiency of the two contractual forms emphasizes the decisive role of maladaptation and renegotiation costs. Because the magnitude of maladaptation costs is a function of the uncertainty and complexity surrounding the transaction we can make the following propositions:

Proposition 3: The lower the traffic uncertainty, the more rigid contracts should be.

Proposition 4: The lower the complexity of the transaction, the more rigid contracts should be.

Proposition 5: The shorter the duration of the contracts, the more rigid contracts should be.

These last three propositions point out the fact that all rigid contracts are necessarily incomplete. This gives rise to maladaptation costs and makes the use of such contracts prohibitively costly in certain situations.

Regarding now renegotiation costs, they are mainly a function of the willingness of the contracting parties to enter or not in conflicts, haggling and friction.

Proposition 6: The lower the reputation capital of the contracting parties, the more rigid contracts should be.

This proposition emphasizes the fact that when the parties decide to devise a flexible contract, they have to account for with whom they sign the contract, as renegotiation will inevitably occur. Thus, reputation is an important dimension.

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

3. Toll Adjustment Processes in Infrastructure Concession Contracts

3.1. The Particular Case of Infrastructure Concessions

The degree of complexity and uncertainty and the likelihood of opportunism come directly to bear in the design of infrastructure concession contracts. By its nature, infrastructure concession, as long-term contracts, involves a high degree of uncertainty. Some might therefore say that there is nothing new here and that most business decisions are taken in the face of uncertainty. But it is a matter of degree, and uncertainty in infrastructure decision is generally much greater than in most ordinary business decisions (Prud'homme 2004). As a matter of fact, forecasting errors and associated risks are characteristics of infrastructure projects. Studies of such errors (Pickrell 1990; Flyvbjerg 1997, 2002, 2003; Odeck 2004) show that construction costs are generally underestimated and traffic overestimated, by large amounts. Errors of 50% or more seem to be the rule rather than the exception.

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

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, toll adjustment processes are particularly of great importance in toll infrastructure concessions, as they condition the monopoly power of the concessionaire *ex post*, during the exploitation phase, and therefore the tariff that can be charged to infrastructure users for the whole length of the concession.

3.2. 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. 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 may miss cost or demand changes specific to a particular transaction and thus adjust tolls imperfectly.

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 have a margin of prices (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 may either have complete freedom in determining the price at or below the ceiling, being however constrained by a limit of toll variation from one year to another, or 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 may be 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), for example, or an indexation to traffic variation (NTEP/TRAFFIC/EPA), or a margin of prices (NTEP/EPA/MARG). Still, even these 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.

Table 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 prices according to an explicit predefined schedule
Definite escalator with a margin (DE/MARG)	Price , escalator, margin	Only adjustment to prices 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 prices 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 prices as specified ex ante
Fixed price with EPA and with a margin (FP/EPA/MARG)	Price, Economic price adjustment formula, margin	Only formulaic adjustment to prices 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 prices 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

3.3. 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. 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.

As a consequence, we may rank the contract types encountered in infrastructure concessions according to a qualitative index of rigidity. The following tables 2 and 3 indicate the ranking of price adjustment processes that are used in the empirical part, where lower numerical values correspond to less rigid contracts.[6] 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.

Besides, there are also significant differences in the *ex ante* costs incurred by the contracting parties in the course of negotiating various forms of concession contracts. We did not address them in our model, but it should be noted that these costs include not only the costs of formalizing the agreement, but also gathering information costs, required for the elaboration of optimal responses to the potential contingencies. Hence, renegotiation contracts, by permitting the parties to negotiate compensation *ex post*, economize on the *ex ante* costs. As contracts become more complete, however, the parties are faced with the prospect of incurring

[6] 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 14 to 11; the second one from 14 to 5. Using the two classifications is a way to see how robust our results are according to the way adjustments are classified.

increasing costs of implementation, due to the necessity to take into account increasingly contingencies.

Table 2: Dependent Variable Used in the Ordered Logit Estimations (11 groups)

	Frequency	Mean
TYPE = 1 if RENEG	3	6,21
= 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/CPI	4	
= 7 if FP/EPA/MARG	10	
= 8 if FP/EPA/TRAFFIC	2	
= 9 if FP/COST or FP/CPI	18	
= 10 if DE or DE/MARG	7	
= 11 if FFP	1	

Table 3: Dependent Variable Used in the Ordered Logit Estimations (5 groups)

	Frequency	Mean
TYPE = 1 if RENEG	3	3,32
= 2 if FREE/NTEP/COST	10	
= 3 if NTEP	20	
= 4 if FP and DE	37	
= 5 if FFP	1	

Our hypothesis is that the degree of contractual rigidity chosen by the contracting parties is influenced by the factors discussed in section 2.

4. Infrastructure Concession Contracts: Data

4.1. Description of the Dataset of Contracts

We have constructed a panel dataset consisting of 71 toll road concession contracts (highways, bridges, channels). These 71 contracts refer to 45 original contracts and to 26 renegotiated contracts, referred to as “supplemental agreements”. These supplemental agreements are mutually agreed-upon modifications to the original contract, and the fact that they create new and different arrangements between the parties make it possible to consider them as new contracts (see Crocker-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. They have been devised with different operators. The oldest contracts in the sample were implemented in 1970, whereas the latest in 2005.

4.2. Contractual Record

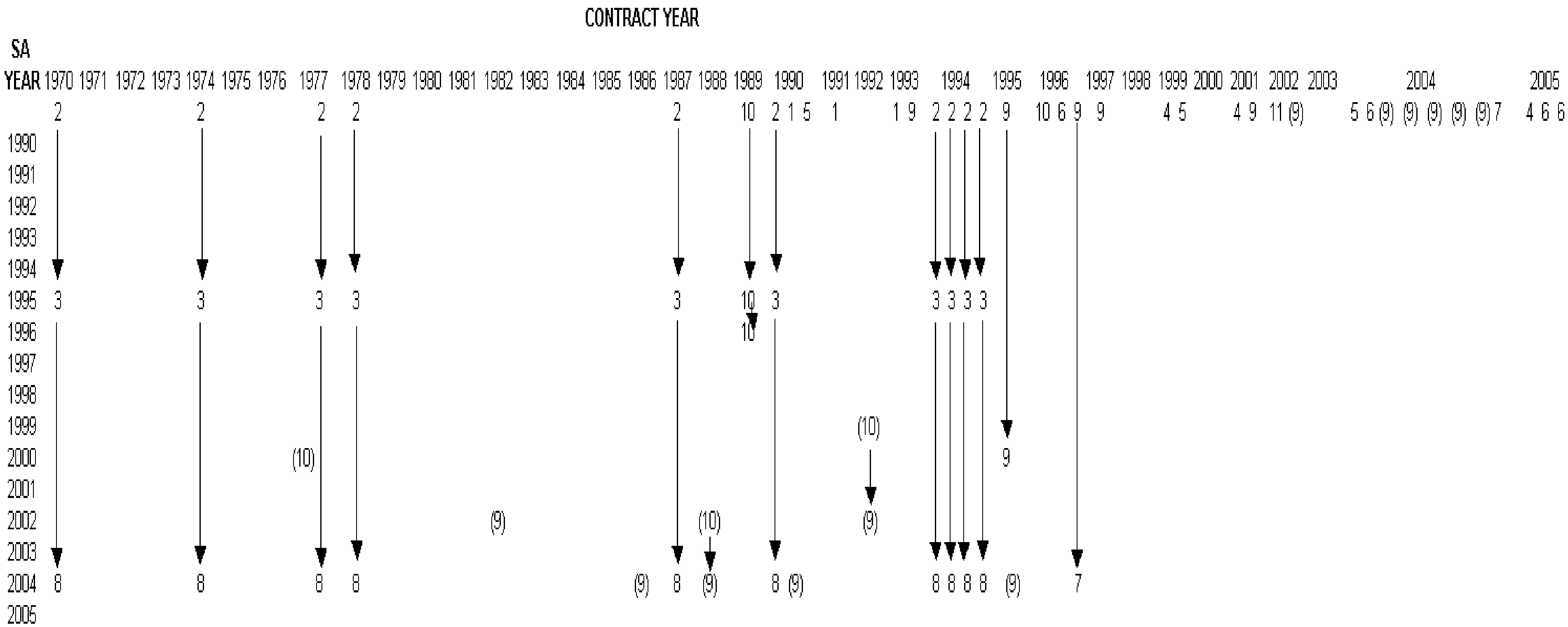
Using the convention for contractual rigidity from Table 2 (11 groups), we present the contractual record in Table 4. The horizontal axis identifies the year in which the contract was negotiated, and the vertical axis indicates the year in which an amendment to the original contract, *i.e.* a supplemental 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 (33% of the original contracts 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 4,3, the mean of those signed between 2000 and 2005 is 7,5.

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 4 : Contractual Observations



4.3. Explanatory variables

The model developed in section 2 suggests several factor that are likely to influence the contractual degree of flexibility chosen by the parties, which in turn should reflect the tradeoff between the costs of implementing more rigid arrangements and the benefits arising from a reduction in opportunistic behaviors. Thus, factors that increase maladaptation costs should make contracts less rigid, while characteristics leading to an increased likelihood of concessionaire opportunism should result in more rigid contracts. 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 or 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: If the project concerns the construction and the exploitation of a road that will be part of a network, the traffic risk will be weaken. If, in contrast, the road (highway, bridge or channel) is a new one in a specific zone ("Greenfield" project) and the demand is very hard to forecast, this uncertainty may be very high. We have obtained data on traffic uncertainty from interviews with CEOs of a French private concessionaire (more information about the data collection process about traffic uncertainty is presented in the Appendix 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 assume that agents have accurate information on traffic uncertainty at the time contracts are negotiated, and that their expectations are rational. We capture this uncertainty in the explanatory variable *TRAFFIC,* which corresponds to the average rating between 1 and 5 given by CEOs 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[7]. 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 is accompanied moreover by uncertainty on construction costs. Indeed, 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 channels). As for traffic uncertainty, data on construction costs uncertainty have been obtained from the rating by practitioners, 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.

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. We might however expect some correlation between the variables *TRAFFIC* and *DURATION*, but the correlation matrix (Appendix 2) indicates that this correlation is quite low. Because contract duration is an

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

endogenous term, we correct for the possibility of simultaneity bias by substituting predicted value *DURATION** from reduced-form estimations of this variable.[8]

Regarding now the magnitude of renegotiation costs, the reputation of concessionaires may serve as a useful guide. Indeed, the public authority has the opportunity to take it into account and consequently modify the contractual terms during what we call the "preferred bidder phase".[9] Banerjee and Duflo (2000) show that there are several mechanisms by which reputation can evolve. First, in those cases where the public authority and the concessionaire[10] have contracted at least once before, the presumption is that both had behaved reliably so that they both now have a better reputation with the other. Nevertheless, the public authority is most often compelled to choose the most efficient concessionaire. This concessionaire may, however, have behaved opportunistically once before with this public authority, which should in turn result in more rigid contracts. We capture this ambiguous effect in the dichotomous variable *REPEATED CONTRACT*. Second, the age of the concessionaire could be also a source of reputation. As a matter of fact, unreliable behavior becomes probably publicly known in the future. Once that happens no one will want to contract with the opportunistic concessionaire and it will probably end up going out of business. This selection process ensures that older concessionaires will typically be more reliable. To capture this effect, we include as an explanatory variable *YOUNG FIRM*, which is a dichotomous variable, taking the value 1 when the leader of the consortium was founded in 1950 or later[11] and 0 otherwise. The hypothesis is therefore that older concessionaires will have more flexible contracts than younger concessionaires. Third, in our sample of contracts, there are private and semi-public

[8] In addition to the exogenous variables already used in the estimations, we included the country concerned by the contract. We obtained a $R^2 = 0{,}63$.
[9] The "preferred bidder phase" is a phase during which the public authority negotiates with a preferred bidder the final terms of the contract.
[10] The term concessionaire, regarding reputation issues, refers to the leader of the consortium.
[11] The choice of the year 1950 is due to the fact that concession contracts are most often very long-term contracts (from 30 to 70 years) and the behavior of an operator founded in 1950 or later is consequently certainly not yet publicly known.

concessionaires. The presumption is that semi-public concessionaires will behave less opportunistically than private operators since they have quite the same interests as the public authority. We use the dichotomous variable *SEMCA*[12] as an additional proxy for the likelihood of future opportunism, and we expect *SEMCA* to decrease the marginal benefits of more rigid agreements.

Finally, the likelihood of future opportunism depends not only on a concessionaire's inherent proclivity to opportunism, but also on the potential success of opportunism in effecting a favorable redistribution. One obvious impediment to concessionaire opportunism is the availability of alternative suppliers. The number of bidders for every project has always been publicly known, practitioners were therefore totally able to inform us in this respect and we include as an explanatory variable *NUMBER OF BIDDERS*. The hypothesis is that the availability of alternative suppliers reduces the potential success and hence the likelihood of concessionaire opportunism, leading to the adoption of less rigid contracts.

The variables used in our estimations are summarized in the following Table 5 and the correlation matrix is given in Appendix 2.

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

Table 5: Data Definitions and Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Definition
TYPE OF ADJUSTEMENT (5 GROUPS)	71	3.323944	.8908206	1	5	Ranking of toll adjustment types in 5 groups (See Table 3)
TYPE OF ADJUSTEMENT (11 GROUPS)	71	6.211268	3.1118	1	11	Ranking of toll adjustment types in 11 groups (See Table 2)
COMPLEXITY	71	2.746479	1.024253	1	5	The average rating on uncertainty on construction costs
TRAFFIC	71	2.492958	1.263479	1	5	The average rating on traffic uncertainty
YOUNG FIRM	67	.761194	.4295717	0	1	1 if the leader of the consortium was founded in 1950 or later ; 0 otherwise
REPEATED CONTRACT	71	.9014085	.3002347	0	1	1 if the leader of the consortium and the public authority have contracted at least once before ; 0 otherwise
SUP AGREEMENT	71	.4647887	.5023086	0	1	1 if the contract is a supplemental agreement; 0 otherwise
NUMBER OF BIDDERS	68	1.632353	1.291816	1	7	The number of bidders for the contract
DURATION	68	396.4412	183.0687	60	1164	The number of months between the completion of the infrastructure construction and the end of the concession
DURATION*	63	378.8311	147.2543	36.137	939.4198	Predicted values for the variable DURATION using instrumental variables technic
TREND	71	7.323944	7.52097	0	35	The difference between the year 2005 and the contract year
TREND2	71	109.4085	218.358	0	1225	TREND*TREND
SEMCA	71	.2112676	.4111132	0	1	1 if the concessionaire is a semi public company; 0 otherwise

5. 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. The first set of 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.

Results are reported in Table 6. Columns 1 and 6 contain only the exogenous variables *COMPLEXITY* and *TRAFFIC*. Column 2 and 7 take into account the reputation effect. They have fewer observations (64) because CEOs did not remember the number of bidders for every contract. The effect of the *SEMCA* variable is only accounted for in the 11 groups sample (Estimation 7) because of an empty cell problem encountered in the classification in 5 groups. The endogenous variable *DURATION* has been then included in column 3 and 9 and corrected for simultaneity in column 4 and 10. Again, there are fewer observations because *DURATION* data are not available for concession contracts that have been awarded through Present-Value-of-Revenue auctions[13]. Finally, we have included in Columns 5 and 11 additional explanatory variables to make sure that there is no bias due to omitted variables.

[13] 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 6: Ordered Logit Estimation Results

	5 groups					11 groups						
	Ologit	Ologit	Ologit	Ologit	Ologit	Ologit	Ologit	Ologit	Ologit	Ologit	Ologit	OLS
	Type of price adjustment (1)	Type of price adjustment (2)	Type of price adjustment (3)	Type of price adjustment (4)	Type of price adjustment (5)	Type of price adjustment (6)	Type of price adjustment (7)	Type of price adjustment (8)	Type of price adjustment (9)	Type of price adjustment (10)	Type of price adjustment (11)	Type of price adjustment (12)
COMPLEX	0.189 0.659	0.258 0.696	0.594 1.515	0.475 1.190	0.187 0.307	0.402 1.496	0.412 1.135	0.462 1.321	0.487 1.273	0.549 1.438	0.540 1.260	0.862* 2.246
TRAFFIC	-0.887*** -3.398	-1.196*** -3.862	-1.295*** -3.888	-1.094*** -3.431	-0.885 -1.547	-0.780*** -3.406	-0.905** -3.026	-1.476*** -4.951	-1.287*** -4.287	-1.431*** -4.698	-1.187*** -3.485	-1.101*** -3.688
YOUNG FIRM		-3.161*** -3.356	-1.924+ -1.909	-1.838 -1.534	-4.032* -2.123		-4.443*** -4.861	-3.954*** -4.810	-4.174*** -4.271	-3.454** -2.984	-3.838* -2.564	-2.313* -2.394
REPEATED CONTRACT		0.033 0.025	-0.382 -0.257	-0.723 -0.496	-1.056 -0.667		-0.346 -0.275	-0.296 -0.254	-0.060 -0.045	-0.491 -0.404	-0.825 -0.654	-1.804 -1.567
NUMBER OF BIDDERS		-0.216 -0.618	0.507 0.812	0.233 0.503	0.578 1.329		-0.132 -0.429	-0.136 -0.482	-0.053 -0.174	0.009 0.025	0.212 0.529	0.585+ 1.814
SEMCA							3.828*** 4.549					
e								0.922*** 3.358	0.887** 3.082	0.863** 3.087	0.756** 2.606	0.434+ 1.689
DURATION			-0.004+ -1.938						-0.003 -1.542			
DURATION*				-0.005 -1.627	-0.006 -1.278					-0.002 -0.593	-0.001 -0.303	-0.007* -2.526
TREND					-0.980*** -4.288						-0.406*** -3.355	-0.544*** -5.749
$TREND^2$					0.024*** 3.733						0.010* 2.430	0.014*** 3.812
SUP AGREEMENT					1.998+ 1.746						0.423 0.684	0.084 0.141
CONSTANT	5.21*** 5.37	8.96*** 4.03	8.53*** 3.56	9.16*** 3.96	19.42*** 4.64	4.25*** 4.94	8.90*** 4.21	10.41*** 4.98	10.94*** 5.06	10.27*** 4.93	12.76*** 5.33	14.549*** 9.185
N	71	64	62	62	62	71	64	64	62	62	62	62
Pseudo R^2	0.098	0.195	0.232	0.212	0.579	0.044	0.235	0.179	0.204	0.177	0.245	0.72

Significance levels: + 0.10 * 0.05 ** 0.01 *** 0.001

The first striking result we observe is that the traffic uncertainty is clearly an important variable, driving the choice of toll adjustment type (estimates 1 & 6). More precisely, the higher the traffic uncertainty, the more flexible the toll adjustment provisions will be. This confirms our proposition 3.

However, the complexity of the project does not seem to be significant. It is only significant under ordinary least squares and not of the hypothesized sign so that a more complex project generates more rigid agreements. This is not consistent with our proposition 4. Nevertheless, this might be explained by the fact that the complexity of the contract mainly concerns the construction phase and thus may not have an impact on toll adjustment processes taking place only during the exploitation phase. Besides, construction cost uncertainty is in concession contracts completely supported by the concessionaire. Thus, the rigidity we observe for more complex projects may be explained by the willingness of the public authorities to delegate the construction risk to the private operator. This is efficient as long as this risk is more appropriately limited and managed by the private contractor.

When we incorporate in the regressions variables reflecting the concessionaires reputation and the potential success of opportunism (estimates 2 and 7), two variables seem particularly important: The experience of the concessionaire (*YOUNG FIRM*) and the fact that the concessionaire is a semi-public company (*SEMCA*). Regarding the variable *SEMCA*, we have controlled for a multicolinearity problem with the complexity and the traffic uncertainty variables using a logit model: Semi-public concessionaires are more probably chosen when the complexity of the project is high and less probably chosen when the traffic uncertainty is high. This is the reason why we have included in the column 8 the variable *e*, which is the residual part of this regression. This residual part amounts to the *SEMCA* variable purged from the part that is explained by *COMPLEXITY* and *TRAFFIC* variables. The results clearly indicate that the fact that the concessionaire is a semi-public company highly rigidifies the contract, even after having corrected for the multicolinearity bias. This is a surprising result as we expected contracts signed with semi-public concessionaires to be less concerned by opportunism problems and thus less prompt to be rigid agreements. Furthermore, recent developments insist on the fact that the presence of public sector agents ensures that some weight is placed on social benefit in decision-making, which should result in the adoption of more flexible contracts (Bennett and Iossa 2005). These unpredicted results may reflect the fact that semi-public concessionaires have almost the same interests as the public authority (the semi-public companies in question are indeed quite completely public) and therefore do not try to negotiate more flexible terms.

The fact that more experienced concessionaires sign more rigid contract and that the *REPEATED CONTRACT* variable has not a significant effect on the choice of toll adjustment process, contrast with what our model predicts. Those results may reflect the fact that contracts are not drafted while accounting for the identity of the contracting parties. This runs counter previous works on optimal contracting (Bajari-McMillan-Tadelis 2003).

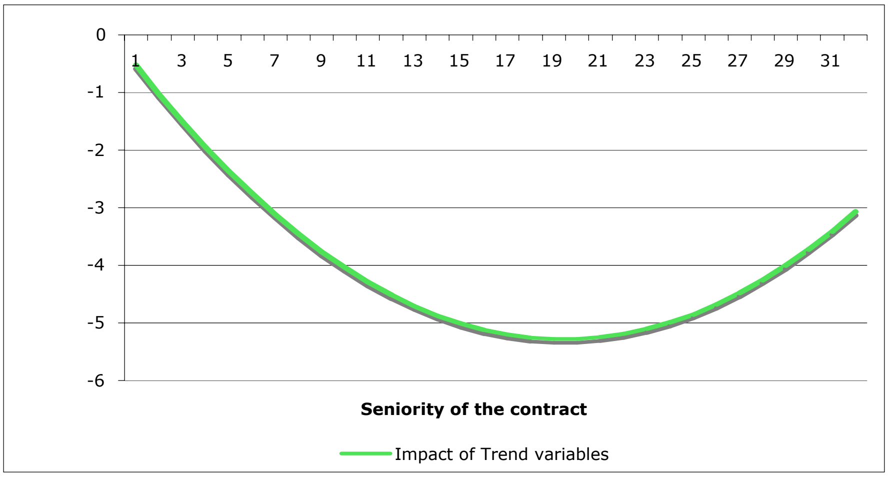
The number of bidders that competed for the contract appears to be irrelevant neither. This result may be explained by the fact that the public authority very scarcely breaches a concession contract even when it faces opportunistic concessionaires, which is supported by the observations of Guasch (2004). This is partly due to the high political and transaction costs of such a breach. Thus, the public authority does not take into account the availability of alternative suppliers when contracting with one concessionaire.

Contracts of longer duration appear to favor more flexible toll adjustment processes in estimates 3 and 12. This result is consistent with the proposition 5: 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. Nevertheless, this effect is not significant in the other estimates. Besides, we observe that results do not change with *DURATION**.

Finally, we have included additional explanatory variables to avoid the omitted-variables bias. The first source of potential omitted-variables bias arises from the fact that some of the contractual observations in the dataset are supplemental agreements. 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. These contractual changes take place either because initial contractual terms were unsuitable, or because the characteristics of the transaction have changed, or because the contracting parties had anticipated initially that they will renegotiate the contract. Thus to account for this last possibility, we include in the regressions the variable *SUP AGREEMENT.* The results indicate the absence of effects specific to supplemental agreements on the design of toll adjustment type (except for the estimation 5 but the sudden change of significance of the *TRAFFIC* variable and the colinearity between *SUP AGREEMENT* and *TRAFFIC* variables – see Annex 1 – cast doubts on this result which is nevertheless of the hypothesized sign).

A second potential source of bias 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 4.2., 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 two variables *TREND* and *TREND2*, the latter addressing the possibility of a non linear effect. The results clearly indicate that the effect of the variable *TREND* is highly significant and generates more rigid toll adjustment provisions, whereas the variable *TREND2* has an effect resulting in the adoption of more flexible arrangements. In other words, older contracts appear to be more flexible compared to the more recent ones, but up to a point, as illustrated by the figure 2 (using the convention for contractual rigidity from Table 2 (11 groups)). The horizontal axis indicates the seniority of the contract, namely the number of years between the year in which the contract was negotiated and the year 2005, and the vertical axis identifies the impact of this seniority on the type of toll adjustment provision chosen. For example, if a contract negotiated in 1985 has a toll adjustment type with a numerical value 4 according to the convention for contractual rigidity from Table 2, this same contract designed in 2005 would correspond to the type 9 or 10, all other things being equal.

Figure 2: Impact of Trend Variables on Toll Adjustment Processes[14]



Thus, the results suggest that there is a trend towards more rigidity in contracts; a rigidity that is not justified by a change in complexity or traffic uncertainty. These results might reflect a political will to limit as much as possible renegotiation and therefore to constrain concessionaires opportunism. Nevertheless, as already discussed, pubic-private contracts require generally a cooperation *ex post* between the contracting parties and this one might be hampered if the contract focuses more on the reduction of the potential for opportunism than

[14] The impact of trend variables is estimated using ordinary least squares (OLS) (estimation 12). We have run the OLS regression only to deal with this impact because ordered logit estimations are otherwise more suitable for our particular case. Indeed, in contrast to ordered logit estimations, the OLS estimates would treat toll adjustment type as a continuous variable, whereas the observed choices are discrete types, thus resulting in inconsistent estimates.

on the process of renegotiating alterations to contracts by nature incomplete and hence imperfects.

6. Conclusion

In this paper, we have argued that it may be misleading to choose toll provisions in infrastructure concession contracts without looking at the characteristics of the project and the contracting parties. In this spirit, we have explored the relationships between the rigidity of toll adjustment provisions and those characteristics and we have made some propositions concerning the need for some projects to be governed by flexible or rigid agreements.

One of our empirical findings is that toll adjustment provisions in infrastructure concession contracts exhibit a wide diversity contrary to what is often written. But more interestingly we have found that this diversity can be explained, to some extent, by traffic uncertainty. This suggests that toll adjustment arrangements in such contracts are not randomly chosen and may be driven by efficiency consideration.

Nevertheless, we have also obtained surprising results suggesting that contracts in our sample are not driven only by efficiency consideration. First, the variables we have used in order to account for the characteristics of the parties appeared to be irrelevant in explaining toll adjustment processes. Thus, in other words, apparently concessionaires reputation does not matter. Second, we observe a trend towards more rigid contracts that is not explained by an evolution of the characteristics of the projects or of the concessionaires. Political considerations might explain this. Lastly, even if we do not address the question of make or buy for the public authorities in this article, we observe that semi-public concessionaires are not randomly chosen but more probably selected for transactions for which traffic uncertainty is low. This result is surprising and seems to run counter recent theoretical findings on this issue (Bennett and Iossa 2005).

Our results also suggest that further studies are needed to shed lights on the concessionaire selection process in public-private contracts. Indeed, the efficiency of observed contractual agreements are also connected to the way concessionaires are selected. We did not address this issue in this paper.

References

Bajari P., Houghton, Tadelis S., [2004], "Bidding for Incomplete Contracts", *Working Paper*.

Bajari P, McMillan R. and Tadelis S, [2003], "Auctions versus Negotiations in Procurement: An Empirical Analysis", *NBER Working Papers,* 9757.

Bajari P, Tadelis S, [2001], "Incentives versus Transaction Costs: a Theory of Procurement Contracts", *Rand Journal of Economics*, 32(3), 387-407.

Banerjee A.V., Duflo E., [2000], "Reputation Effects and the Limits of Contracting: A Study of the Indian Software Industry", *Quarterly Journal of Economics*, 115(3), 989-1017.

Bennett J., Iossa E., [2005], "Contracting Out Public Service Provision to Not-For-Profit Firms", *CMPO Working Paper No. 05/124*.

Cour des Comptes, [1998], "La politique autoroutière française", *rapport de la Cour des Comptes*, politique autoroutière -2-.

Crocker K.J., Masten S.E., [1991], "Pretia ex Machina?: Prices and Process in Long Term Contracts", *Journal of Law and Economics*, 34, 64-69.

Crocker K.J., Reynolds K.J., [1993], "The Efficiency of Incomplete Contracts: An Empirical Analysis of Air Force Engine Procurement", *Rand Journal of Economics*, 24, 126-146.

Doni N., [2005], "The Importance of Reputation In Awarding Public Contracts", *Working Paper*.

Engel E., Fisher R., Galetovic A., [1997], "Highway Franchising: Pitfalls and Opportunities", *American Economic Review*, 87, 68-72.

Engel E., Fischer R., Galetovic A., [2002], "A New Approach to Private Roads", Regulation, Fall 2002, 18-22.

Engel E., Fisher R., Galetovic A., [2003], "Privatizing Highways in Latin America: Fixing What Went Wrong?", *Economia, The Journal of LACEA*, 4, 129-158.

Engel E., Fisher R., Galetovic A., [2005], "Privatizing Highways in the United States", *Working Paper*.

Estache A., [2004], "PPI partnerships vs. PPI divorces in LDCs (or are we switching from PPPI to PPDI?)", *World Bank and ECARES.*

Flyvberg, Bent, Nils Bruzelius and Werner Rothengatter, [2003]. "Megaprojects and Risk – An Anatomy of Ambition", *Cambridge: Cambridge University Press*, 207p.

Flyvbjerg, Bent, Mette Skamris Hom and Soren L. Buhl. [2002]. "Underestimating Costs in Public Works Projects: Error or Lie?". *Journal of the American Planning Association,* 68, 279-95.

Flyvbjerg, Bent & M. Skamris. [1997]. "Inaccuracy of Traffic Forecasts and Cost Estimates on Large Transport Projects", *Transport Policy,* 4(3), 141-6.

Gomez-Ibanez J.A. and Meyer J. R., [1993], "Going Private: The International Experience with Transport Privatization", *The Brookings Institution*, Washington, D.C.

Grout P. and Stevens M., [2003], "The Assessment: Financing and Managing Public Services", *Oxford Review of Economic Policy*, 19, 215-234.

Guasch J.L., Laffont J.J., Straub S., [2003], "Renegotiation of Concession Contracts in Latin America", *World Bank Policy Research Working Paper 3011*,Washington D.C.

Guasch J.L., Laffont J.J., Straub S., [2005], "Concessions of Infrastructure in Latin America: Government-led Renegotiation", *Working Paper*.

Guasch J. Luis, [2004], "Granting and Renegotiating Infrastructure Concessions: Doing it Right", *World Bank Institute*.

Hart O.D., [1995], "Firms, Contracts, and Financial Structure", *Oxford and New York: Oxford University Press, Clarendon Press*.

Hart O.D., [2003], "Incomplete Contract and Public Ownership: Remarks, and an Application to Public-Private Partnerships", *The Economic Journal*, 113, 69-76.

HM Treasury, [2003], "PFI: meeting the investment challenge", The Stationery Office, London, UK.

Jolls C., [1997], "Contracts as Bilateral Commitments: A New Perspective On Contract Modification", *Journal of Legal Studies*, 26, 203-237.

Laffont, J.J., [2005], "Regulation and Development", *Cambridge University Press*, 292p.

Odeck, James, [2004], "Cost Overruns in Road construction – What Are their Sizes and Determinants?", *Transport Policy,* 11 (1), 43-53.

Pickrell, D., [1990], "Urban Rail Transit Projects: Forecasts Versus Actual Ridership and Cost". Washington, D.C.. Department of Transportation.

Prud'homme R., [2004], "Infrastructure and Development", *Annual Bank Conference on Development Economics*, Washington, May 3-5, 2004.

Saussier S., [2000], "Transaction Costs and Contractual Completeness", *Journal of Economic Behavior and Organization*, 42, 189-206.

Schugart C., [2005], "The Selection of Concessionaires In the Urban Water Sector: Does the Standard Procurement Paradigm Fit ?", *Working Paper*.

Tirole J., [1999], "Incomplete Contracts: Where Do We Stand ?", *Econometrica*, 67, 741-781.

Williamson O.E., [1976], "Franchise Bidding for Natural Monopolies – In General and with Respect to CATV", *Bell Journal of Economics,* 7, 73-104.

Williamson O.E., [1985], "The Economic Institutions of Capitalism", *New-York Free Press*.

Appendix 1: Data Collection about Traffic Uncertainty

Some of the data used in this paper (*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. 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: Correlation Matrix

Variable	TYPE OF ADJUST (5 GROUPS)	TYPE OF ADJUST (11 GROUPS)	COMPLEXITY	TRAFFIC	YOUNG FIRM	REPEATED CONTRACT	SUP AGREEMENT	NUMBER OF BIDDERS	DURATION	DURATION*	TREND	TREND2	SEMCA
TYPE OF ADJUST (5 GROUPS)	1.0000												
TYPE OF ADJUST (11 GROUPS)	0.9225	1.0000											
COMPLEXITY	-0.2336	-0.1027	1.0000										
TRAFFIC	-0.5062	-0.3717	0.6938	1.0000									
YOUNG FIRM	-0.1500	-0.2813	-0.3877	-0.3727	1.0000								
REPEATED CONTRACT	-0.0557	-0.0885	-0.2075	-0.1821	0.3687	1.0000							
SUP AGREEMENT	0.4403	0.2587	-0.2999	-0.4929	0.2721	0.2783	1.0000						
NUMBER OF BIDDERS	-0.0807	0.0169	0.4209	0.3860	-0.5173	-0.4125	-0.4382	1.0000					
DURATION	-0.3909	-0.4465	0.3655	0.3445	0.0305	-0.3026	-0.3578	0.4338	1.0000				
DURATION*	-0.3540	-0.4063	0.4509	0.4250	0.0376	-0.3733	-0.4414	0.5352	0.8106	1.0000			
TREND	-0.6915	-0.6218	0.0893	0.4696	-0.1313	-0.0379	-0.3986	0.1430	0.1079	0.1264	1.0000		
TREND2	-0.5617	-0.4938	-0.0565	0.3797	-0.0002	0.0420	-0.3621	0.0250	0.0550	0.0636	0.9168	1.000	
SEMCA	0.4383	0.5387	-0.2229	-0.4994	0.2826	0.1513	0.0862	-0.2382	-0.3162	-0.3901	-0.4516	-0.3038	1.0000