

# The Cost of Contract Renegotiation: Evidence from the Local Public Sector\*

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Contract theory claims that renegotiation prevents from reaching the efficient solution that could be obtained under full commitment. Assessing the cost of renegotiation remains an open issue from an empirical viewpoint. We fit a structural principal-agent model with renegotiation on a set of contracts for urban transport services. The model captures two important features of the industry as only two types of contracts are used (fixed-price and cost-plus) and subsidies are greater following a cost-plus contract than following a fixed-price one. We conclude that the welfare gains from improving commitment would be significant but would accrue mostly to operators.

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Real world regulatory relationships are ongoing processes in changing environments. Parties lay down arrangements for trading goods and services covering several periods. However, they often recontract as new information on market demand and costs structure becomes available. Although economic theory has devoted considerable attention to understanding dynamic contractual relationships and especially how contracts are renegotiated over time, the empirical literature on those issues lags much behind both in terms of volume and scope.

Contract theory claims that, under a variety of circumstances, renegotiation imposes transaction costs. Although renegotiation improves contracting *ex post*, it has also perverse effects on the parties' *ex ante* incentives.<sup>1</sup> Overall, those costs prevent those parties from reaching the informationally constrained efficient solution that could have been achieved under full commitment. Yet, an open issue from an empirical viewpoint remains to assess the welfare losses associated with renegotiation. Furthermore, another important question especially from a policy perspective is to evaluate the distribution of these losses among contracting parties.

Indeed, progresses on these fronts are crucial, especially for practitioners who are eager to evaluate the performances of various contractual arrangements found in real-world practices. In this respect, the French urban transportation sector offers a particularly attractive field for study. Motivated

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<sup>1</sup>Such perverse incentives arise in at least three occasions. First, information may be incorporated in contract design only at a slow pace as in the literature on adverse selection under imperfect commitment (Dewatripont, 1989, Hart and Tirole, 1988, Laffont and Tirole, 1993-Chapter 10, Rey and Salanié, 1996, Bester and Strausz, 2001, Laffont and Martimort, 2002-Chapter 9, among others). Second, the threat of regulatory hold-up may impede specific investments which requires costly governance and various safeguards (Williamson, 1985). Finally optimal risk-sharing arrangements may be disrupted (Fudenberg and Tirole, 1990). Only the first of these impediments to contracting will be investigated in this paper.

by a concern for improving *ex ante* competition among potential operators, the 1993 Transportation Law imposed that franchise contracts must be re-auctioned and ‘re-negotiated’ (in a sense to be discussed later) every five years by public authorities in charge of regulating transport operators. Since then, practitioners have repeatedly complained that this institutional constraint on contract duration is too tight. Expectations that welfare gains could be achieved by increasing contract duration is at the source of an ongoing political debate and has often been considered as a justification of the operators’ political activism.

*Motivation.* This paper has two main objectives. First, we construct and estimate a structural principal-agent model of contract renegotiation in the French urban transport sector. A basic assumption of this model is that contracting takes place under asymmetric information: Operators are privately informed on their innate costs at the time of contracting with public authorities. Second, we use those estimates in a counterfactual experiment whose goal is to recover not only the welfare gains but also their distribution if full commitment were feasible. These gains turn out to be significant although unevenly distributed: Operators would be net winners whereas taxpayers/consumers would lose had contract length been extended.

Our model accounts for an important feature of the industry. In practice, only two kinds of contracts are used by local public authorities (principals) to regulate the service: Cost-plus and fixed-price contracts. It is well-known from Laffont and Tirole (1993, Chapter 1), Rogerson (1987), Melumad, Mookherjee and Reichelstein (1992) and Mookherjee and Reichelstein (2001) that menus of linear contracts might facilitate self-selection of operators.<sup>2</sup> Of much importance from a practical point of view, these menus well approximate and sometimes replicate what more complex optimal non-

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<sup>2</sup>In addition, linear contracts also have nice robustness properties under cost uncertainty (Laffont and Tirole 1993-Chapter 1 p.109, and Caillaud, Guesnerie and Rey, 1992).

linear contracts would do.<sup>3</sup> In this respect, Rogerson (2003) pointed out that, in most real-world procurement contexts, a menu with only two items (i.e., one cost-plus and one fixed-price contracts) is enough to achieve much of the gains from trade, even under asymmetric information.<sup>4</sup>

A second important feature of the urban transportation sector is that subsidies (or ‘*compensations*’ as they are often referred to by practitioners) proposed to operators increase over time, no matter the characteristics of the service. Our theoretical model provides a rationale for such patterns. Increasing subsidies result from the local authorities’ limited ability to commit and the fact that information on the operator’s cost structure is revealed over time. This point is familiar from the agency literature on limited commitment. However, it is revisited here in an institutional context where only menus with two options (fixed-price/cost-plus) are feasible. Whereas the existing theoretical literature on limited commitment has focused on discrete type models to derive fully optimal renegotiation-proof contracts but is often criticized for its lack of tractability, we import much of the tractability of Rogerson (2003)’s model into a dynamic framework where contracts are renegotiated over time.<sup>5</sup> So doing, we look for a theoretical modeling consistent

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<sup>3</sup>Laffont and Tirole (1993, Chapter 1) showed that a convex optimal nonlinear cost reimbursement rule can be implemented with a menu of linear contracts. Wilson (1993) and McAfee (2002) demonstrated that such menus might already fare well even when restricted to a few items.

<sup>4</sup>More specifically, Rogerson (2003) supposed that the firm’s innate cost which is its private information is uniformly distributed and showed that this simple menu can secure three-fourth of the surplus that an optimal contract would achieve. Chu and Sappington (2007) challenged this result beyond the case of a uniform distribution. On a related note, Schmalensee (1989), Reichelstein (1992), Bower (1993), and Gasmi, Laffont and Sharkey (1999) investigated the value of relying on a single linear contract and concluded also on the good welfare performances achieved with such a rough contract design.

<sup>5</sup>The static analysis in Rogerson (2003) cannot cover the rich dynamic patterns observed in our data set, in particular the move towards fixed-price contracts as time passes.

with our data set. In particular, it is a prerequisite to consider a continuum of types for evaluating a meaningful distribution of cost parameters in our empirical model and neatly characterize the probabilities of various contractual regimes (i.e., cost-plus, fixed-price, and changes over time from cost-plus to fixed-price contracts).

*Empirical analysis.* The theoretical model readily boils down to an econometric set-up whose parameters are estimated under a scenario where renegotiation takes place. To understand the source of estimation bias that would arise had we wrongly assumed full commitment, it is useful to come back on the basic intuition underlying the trade-off between *ex post* efficiency and *ex ante* incentives that appears under renegotiation. To be acceptable, renegotiation must raise subsidies so that even operators which are only mildly efficient may end up choosing fixed-price contracts. These efficiency gains also provide more rents to the most efficient operators who enjoy increased subsidies. From a welfare point of view, renegotiation is thus more attractive when the social value of the operators' effort in cutting costs is greater. Only in this case, the efficiency gains from renegotiation dominate its costs in terms of extra rents. Wrongly assuming full commitment when analyzing our data would thus amount to underestimate the social value of effort and overestimate information rents.

Our empirical analysis yields two main results. First, it provides an estimate of the congruence of objectives between the operator and the local government in charge of regulating the service. The operator's bargaining power when negotiating contracts depends on political preferences. Right-wing municipalities are more prone to favor private operators than left-wing ones.<sup>6</sup>

Second, using our estimates of the operator's innate cost distributions and

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<sup>6</sup>Kalt and Zupan (1984, 1990) provided evidence on the fact that policymakers' ideology may have a significant impact on regulatory outcome.

other parameters of the model, we evaluate the welfare gains that would be obtained when moving to the full commitment solution. The intertemporal subsidies under full commitment are higher than under renegotiation, so that taxpayers are net losers from a hypothetical increase in contract length. However, the welfare gains are significant. Taxpayers bear an increase in tax burden of 8 million Euros whereas operators see their rent increase by roughly 8.2 million Euros. This provides a strong rationale for the operators' lobbying effort towards increasing contract duration.

*Literature review.* Our model belongs to the recent empirical literature on regulatory contracts. As already explained, this paper contributes to the ongoing empirical debate on the value of using simple menus of contracts. In a pioneering work, Wolak (1994) estimated the production function of a Californian water utility, and argued that complex nonlinear regulatory mechanisms *à la* Baron and Myerson (1982) are used. Assuming instead that costs are observable, Gasmi, Laffont and Sharkey (1997), Brocas, Chan and Perrigne (2006) and Perrigne and Vuong (2007) considered also such complex regulatory schemes to estimate costs and demand parameters of structural models. Other empirical studies instead argued that complex mechanisms might not be so useful. Bajari and Tadelis (2001) focused on the private construction industry in the U.S. and noticed that most contracts are either cost-plus or fixed-price. The reason for such restricted menus is that public authorities face a trade off between providing *ex ante* incentives with fixed-price contracts and avoiding *ex post* transaction costs due to costly renegotiation with cost-plus arrangements. Considering contracts in the automobile insurance industry, Chiappori and Salanié (2000) restricted the analysis to menus with only two types of coverage. In the field of transportation, Gagnepain and Ivaldi (2002) focused on the incentive effects of cost-plus and fixed-price contracts. They measured actual welfare related to real regulatory practices, and compared this measure to what would have been achieved

with more complex mechanisms. We instead model contract design in a dynamic context.

In that respect, our paper is also related to Dionne and Doherty (1994). These authors focused on the car insurance industry in California and suggested that insurers may use long-term contracts to enhance efficiency and attract portfolios of low-risk drivers. Our empirical analysis shows the extent to which long-term contracts may benefit not only principals (hereafter public authorities) but also agents (operators).

*Organization of the paper.* Section I provides an overview of the French urban transportation sector. Section II presents our theoretical model and characterizes the optimal menu of contracts (fixed-prices/cost-plus) both under full commitment and renegotiation. Section III develops our empirical method. Section IV evaluates the welfare gains when moving to full commitment and their distribution between operators and taxpayers. Section V discusses other potential hypothesis that could be considered to explain the pattern of subsidies observed in practice. Section VI highlights alleys for further research.<sup>7</sup>

## I The French Urban Transportation Industry

As in most countries around the world, urban transportation in France is a regulated activity. In each urban area of significant size endowed with a transport network, a local authority (a city, a group of cities or a district) contracts with a single operator to provide the transport service. Regulatory rules prevent the presence of several suppliers on the same network. A distinguishing feature of France compared to most other OECD countries is that, in 2002, about 80 percent of local operators are private and are owned by

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<sup>7</sup>Proofs of the theoretical results are relegated to an online Appendix.

three large companies, two of them being private while the third one is semi-public.<sup>8</sup> These companies, defined by their respective ownership structures and market shares (in terms of number of networks operated) are: KEO-LIS (private, 30 percent), TRANSDEV (semi-public, 19 percent), CONNEX (private, 25 percent). In addition there are a small private group, AGIR, and a few public firms fully controlled by local governments.

## A Economic Environment

The 1982 Transportation Law establishes a decentralized decision-making process concerning the local transport policy and provides regulatory guidelines. Each local authority now organizes its own transportation system by setting route and fare structures, capacity, quality of service, conditions for subsidizing the service, levels of investment and ownership nature. The local authority may operate the network directly or it may rely on an operator. In this case, a formal contract defines the regulatory rules that the operator must follow as well as a cost-reimbursement scheme.<sup>9</sup>

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<sup>8</sup>For an overview of the regulation of urban transportation systems in the different countries of the European Union, the United States and Japan, see IDEI (1999).

<sup>9</sup>Since 1993, *'beauty contests'* are required to allocate the building and management of new infrastructures for urban transportation when the date for contract renewal comes. However, very few networks have changed operators from one regulatory period to the other until recently. Documentary investigations shed light on the fact that awarding transport operations through tenders does not necessarily foster ex ante competition since most local authorities usually receive bids from only one firm, namely the operator which is already in charge. Several reasons might explain this phenomenon. First, local authorities are either reluctant to implement the law or do not have enough expertise to launch complex calls for tender. Second, the three groups owning most of the urban operators in France are located on specific geographical areas which restricts competition. Finally, these groups also operate other municipal services such as water distribution or garbage collection, which makes it even harder for public authorities to credibly punish operators



In most urban areas, operating costs are on average twice as high as commercial revenues. Budgets are rarely balanced without subsidies. One reason is that operators face universal service obligations and must operate in low demand areas. Low prices are maintained to ensure affordable access to all consumers of public transportation. Moreover, special fares are given to targeted groups like seniors and students. Subsidies come from the State's budget, the local authority's budget, and a special tax paid by local firms (employing more than nine full-time workers).

Undertaking a welfare analysis of regulatory schemes requires a database that encompasses both the performance and the organization of the French urban transport industry. Such a database was created in the early 1980s from an annual survey conducted by the *Centre d'Etude et de Recherche du Transport Urbain* (CERTU, Lyon) with the support of the *Groupeement des Autorités Responsables du Transport* (GART, Paris), a nationwide trade organization that gathers most of the local authorities in charge of a urban transport network. This rich source is a unique tool for comparing regulatory systems both across space and over time. For homogeneity purposes, we have selected all urban areas of more than 100,000 inhabitants. Indeed, smaller cities may entail service and network characteristics that differ significantly from those in bigger urban areas. Discarding these smaller cities allows us to identify in a more satisfactory manner differences in inefficiencies and cost-reducing activities across operators. In addition, the sample does not include the largest networks of France, i.e., Paris, Lyon and Marseille, as they are not surveyed. Overall, the panel data set covers forty-nine different urban transport networks over the period 1987-2001. Note finally that we only focus on transport networks where the operator is a private entity. This rules out the so-called *Régies municipales* where the service is fully integrated within the city administration, like in Paris or Marseille, as these cases are not following bad performances.

concerned with the principal-agent problem at the heart of our investigation.

We assume that the network operator has private information about its innate technology (adverse selection) and that its cost-reducing effort is non-observable (moral hazard). Because French local authorities exercise their new powers on transportation policy since the enactment of the 1982 Law only, and since they usually face stringent financial constraints, their limited auditing capacities is recognized among practitioners. A powerful and well-performed audit system needs effort, time and money. French experts on urban transportation blame local authorities for being too lax in assessing operating costs and often point at their lack of expertise.<sup>10</sup> The number of buses required for a specific network, the costs incurred on each route, the fuel consumption of buses (which is highly dependent on drivers' skills), the drivers' behavior toward customers, the effect of traffic congestion on costs, are all aspects for which operators have much more data and a better understanding than public authorities. This suggests the presence of adverse selection on the innate technology in the first place. Given the technical complexity of these issues, it should be even harder for the local authority to assess whether, and to what extent, operators undertake efforts to provide appropriate and efficient management. Moral hazard naturally arises on top of the adverse selection problem. When compounded, those informational asymmetries play a crucial role in the design of contractual arrangements

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<sup>10</sup>The French urban transport expert O. Domenach has argued that *"the regulator is not able of determining the number of buses which is necessary to run the network. The same comment can be made regarding the fuel consumption of each bus. The regulators are generally general practitioners instead of transport professionals. Hence, the (re)negotiation of contracts between regulators and operators is not fair."* See Domenach (1987).

and financial objectives.<sup>11,12</sup>

## B Regulatory Contracts

To perform the econometric analysis, the basic idea is to consider that each observation in the database is the realization of a regulatory contract for a given transport system in an urban area during a time period.

As already mentioned, two types of regulatory contracts are implemented in the French urban transport industry. Fixed-price regimes are high-powered incentive schemes, while cost-plus contracts do not provide any incentives for cost reduction. Over the period of observation, fixed-price contracts are employed in 55.5 percent of the cases.

On average, contracts are signed for a period of 5 to 6 years, which in most cases allows us to observe several regulatory arrangements for the same

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<sup>11</sup>Gagnepain and Ivaldi (2002) confirmed through a test that adverse selection and moral hazard are two important features of the industry. They showed that a regulatory framework which encompasses these two ingredients performs well to explain data.

<sup>12</sup>Three additional remarks should be made. First, private information on demand is not a relevant issue in our industry. Local governments are well informed about the transportation needs of citizens. The number of trips performed over a certain period is easily observed, and the regulator has a very precise idea of how the socio-demographic characteristics of a urban area fluctuate over time. Second, we do not address the issue of determining what should be the optimal rate-of-return on capital. The rolling stock is owned by the local government for a vast majority of networks. In this case, the regulator is responsible for renewing the vehicles, as well as guaranteeing a certain level of capital quality. Finally, we rule out the possibility of risk sharing in the contractual relationships between the operators and the regulators since the provision of transport services does entail relatively predictable cost fluctuations for the operators. Uncertainty on costs and demand is potentially relevant in small networks but, as explained above, those networks are not considered in our analysis.

network. Overall, we observe 136 different contracts. In the same network, the regulatory scheme may switch from cost-plus to fixed-price or from fixed-price to cost-plus between two regulatory periods. We observe 20 changes of regulatory regimes, most of them (i.e., 17) being switches from cost-plus to fixed-price regimes. These changes occur because the same local authority may be willing to change regulatory rules, or because a new government is elected and changes the established rules. Note however that a change in the political preference of the local government does not necessarily imply an early renegotiation of the contract before its term. Newly elected local governments are indeed committed to the contracts signed by their predecessors. We detect 22 changes of local governments in our database. Finally, as already suggested, very few changes of operators are observed over our period of observation. Indeed, only 2 new operators appear between 1987 and 2001.

An important feature of the industry is that the amount of subsidies paid to the operator under a fixed-price regime depends on the contractual arrangement from one period to another. Subsidies are higher for fixed-price regimes when a cost-plus scheme is implemented in the previous period, compared to subsidies paid with a series of fixed-price schemes. To establish that this feature is present in the data, we run a simple regression of the log subsidy paid on a set of covariates, namely the log number of vehicles in the operator's rolling stock, the log size of the transport network in kilometers, whether the observed regulator is right-wing or not, a dummy variable  $CF$  indicating whether the observed fixed-price contract is implemented after a cost-plus regime or not, and a set of firms fixed effects.<sup>13</sup> The  $CF$  dummy is positive and significant at the 1 percent level. On average, subsidies paid

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<sup>13</sup>Estimation results are on 392 observations (firms fixed effects included but not reported, standard errors are provided in parenthesis):  $\log Subsidy = 4.87 + 0.68 \log Rolling\ Stock + 0.23 \log network - 0.11 Right-Wing + 0.34 CF$ .  
(0.26) (0.05)  
(0.03) (0.03) (0.09)

under fixed-price after a cost-plus are 40.9 percent higher than those observed in the case of a sequence of fixed-price regimes. The theoretical model below accounts for the features of the regulatory contracts used in the French urban transportation industry and explains the dynamic patterns of subsidies.

## II Theoretical Model

The model adapts the lessons of the contracting literature under imperfect commitment to the regulatory contracts just described. First, operators choose between fixed-price or cost-plus contracts. Second, subsidies may increase over time. We argue below that such patterns arise when contracts are renegotiation-proof. This positive model is then compared to an hypothetical setting where regulators could commit but optimal subsidies would then remain constant over time.

Generalizing the objective functions used in Baron and Myerson (1982) and Laffont and Tirole (1993), the preferences of the local authority (the ‘principal’) are defined as:

$$W = S - (1 + \lambda)t(c) + \alpha U$$

where  $S$  is the gross surplus generated by the service and  $U$  is the profit of the operator.<sup>14</sup> Subsidies  $t(c)$  raised by means of a distortionary taxation entail some dead-weight loss that is captured by introducing a positive cost of public funds  $\lambda > 0$ .

The municipality’s payment to the firm (the ‘agent’) depends on whether fixed-price or cost-plus contracts are used. For a fixed-price contract, the

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<sup>14</sup>Implicitly, we consider a setting where the elasticity of demand is small which is a reasonable assumption in the case of transportation in the medium term horizons we are considering here. In other words, the surplus is basically constant. See Oum, Waters II, and Yong (1992).

principal offers a fixed payment  $t(c) \equiv b$  for any realized cost  $c$ . With a cost-plus contract, the principal reimburses the firm's cost  $c$  and  $t(c) \equiv c$  for all  $c$ .

Public authorities might differ in terms of the weight left to the operator's profit in their objective functions. To have a meaningful trade-off between the dual objectives of extracting the contractor's information rent and inducing efficient cost-reducing effort, we assume that  $\alpha < 1 + \lambda$  so that, overall, one extra euro left to the firm is socially costly. Various motivations might justify such preferences of local governments. The parameter  $\alpha$  might capture the firm's bargaining power in tender offers and, as such, reflect the level of *ex ante* competition among potential operators.<sup>15,16</sup> In view of our empirical study, we may also distinguish local governments according to their political preferences. Rightist (resp. leftist) local governments commend more (resp. less) rent for the private operator. This corresponds to higher values of  $\alpha$ .

Turning to the cost structure, we follow Laffont and Tirole (1993, Chapter 1) and Rogerson (2003) in considering that the observable cost of one unit of the service  $c$  blends together an adverse selection component  $\theta$ , the innate efficiency of the service, and a cost-reducing managerial effort  $e$ .<sup>17</sup> We

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<sup>15</sup>In this sector, *ex ante* competition is not so fierce. Indeed, operators from different groups mostly avoid head-to-head competition and generally bid for markets in distinct urban areas. The decision  $n^0$  05-D-38 of the French *Conseil de la Concurrence* shows that competition authorities are well-aware of this downstream collusion between potential operators. In more than 60 percent of cases, there is indeed only one bidder. This potential horizontal collusion is captured in ad hoc way in our framework through the parameter  $\alpha$ . The benefit of such an ad hoc specification of the intensity of potential downstream competition comes from a better fit to the real-world practices while it fortunately eases the analysis of the contractual dynamics.

<sup>16</sup>Following Baron (1989), Laffont (1996) and Faure-Grimaud and Martimort (2003), these preferences might also result from a political equilibrium among various forces at the local level.

<sup>17</sup>In accordance with the lack of expertise in practice, we assume that the public au-

postulate the standard functional form:

$$c = \theta - e.$$

Effort is costly for the firm's management and the corresponding non-monetary disutility function  $\psi(e)$  is increasing and convex ( $\psi' > 0$ ,  $\psi'' > 0$ ) with  $\psi(0) = 0$ . The intrinsic efficiency parameter  $\theta$  is drawn once and for all before contracting from the interval  $[\underline{\theta}, \bar{\theta}]$  according to the common knowledge cumulative distribution  $F(\cdot)$  which has an everywhere positive and atomless density  $f(\cdot)$ . Following the screening literature, we assume that the monotone hazard rate property holds,  $\dot{R}(\theta) > 0$  where  $R(\theta) = \frac{F(\theta)}{f(\theta)}$  so that the optimization problems considered below have quasi-concave objectives.<sup>18</sup>

With those notations in hand, we may as well write the firm's profit as:

$$U = t(c) - c - \psi(e).$$

## A Full Commitment

Suppose that the local government offers a long-term contract which covers two contracting periods. The principal can commit to any pattern of subsidies and cost reimbursement rules over time and can reach thereby the highest possible intertemporal payoff. This benchmark is attractive to evaluate the costs of renegotiation later on.

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thority has no auditing capabilities and cannot check whether high costs are due to high innate inefficiency or to low efforts. Adding the possibility of audit would relax incentive problems and making higher power incentives (i.e., fixed-price contracts) more attractive (Baron and Besanko, 1984a, and Khalil, 1997).

<sup>18</sup>For the sake of our empirical analysis, it is worth noticing that the same operator could have different realizations of its innate cost on two different markets. This assumption captures the fact that costs on a given network are to a large extent idiosyncratic.

Let  $\delta$  be the discount factor and let us normalize the length of the first-period accounting period so that first-period welfare and profits receive the weight  $\beta = \frac{1}{1+\delta}$  when computing net present values of those quantities.

Consider first a two-period fixed-price contract which entails subsidy  $t_i(c) = b_i$  in period  $i$ . With such fixed-price contract, the principal passes onto the operator all incentives to save on costs. Let  $e^*$  be the corresponding first-best effort such that  $\psi'(e^*) = 1$ , and denote by  $k = e^* - \psi(e^*)$  its social value. This long-term contract yields to the firm the (normalized) intertemporal payoff

$$\beta b_1 + (1 - \beta)b_2 - \theta + k.$$

Instead, with a cost-plus contract covering both periods, the operator is always reimbursed for his costs  $\theta$  so that he exerts no effort (i.e.,  $e = 0$ ) and his payoff is zero.<sup>19</sup>

By incentive compatibility, if any given type prefers a fixed-price contract, more efficient types also do so. The types interval is thus split into two subsets. Efficient operators take the fixed-price contract whereas inefficient ones go for the cost-plus. The marginal operator with type  $\theta^*$  is just indifferent between those two options:

$$\theta^* = \beta b_1 + (1 - \beta)b_2 + k.$$

Only the most efficient operators such that  $\theta \leq \theta^*$  earn an information rent

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<sup>19</sup>The operator focuses on cost-reducing effort only and is not responsible for improving the quality of the service. Quality entails various dimensions such as the size of the network, the number and size of lines, the number of stops, the frequency of the service, and the age of the rolling stock which are indeed observable and regulated by contract.



$$\theta^* - \theta.^{20,21}$$

**Proposition 1** *Under full commitment, the optimal fixed-price contract is the twice-repeated version of the static optimal one. The subsidy  $b^F$  is constant over time:  $b_1^F = b_2^F = b^F$  with*

$$(1) \quad k = \left(1 - \frac{\alpha}{1 + \lambda}\right) R(b^F + k).$$

*The most efficient firms ( $\theta \leq \theta^F = b^F + k$ ) choose this two-period fixed-price contract. The least efficient firms ( $\theta \geq \theta^F = b^F + k$ ) operate under a cost-plus contract for both periods.*

The optimal menu of contracts trades off efficiency and rent extraction. Offering a fixed price with a sufficiently large subsidy would ensure that the operator exerts the first-best effort whatever his innate technology. However, doing so also leaves too much information rent to the most efficient types and this is socially costly. A cost-plus contract nullifies this rent but also destroys incentives to reduce costs.

Under full commitment, the optimal contract is the twice-repeated version of the optimal static contract, a by-now standard result in the literature.<sup>22</sup>

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<sup>20</sup>From an empirical point of view, the econometrician only observes the choices made by operators, i.e., a single item (either long-term fixed-price or cost-plus) and not the specific negotiation process that leads to this choice. Following the mechanism design tradition, this process is captured because principals offer menus among which operators with different types self-select.

<sup>21</sup>The operator's choice between taking either a two-period fixed price contract or a cost-plus one reveals information on his type. After this choice becomes publicly known, the public authority can assess whether that type is above the threshold  $\theta^*$  or not. Under full commitment, the public authority does not use such information to refine contractual offers in the future since no such offer is ever made.

<sup>22</sup>See Baron and Besanko (1984b) and Laffont and Martimort (2002, Chapter 8).

Given that the economic environment is stationary, the trade-off between rent extraction and efficiency remains the same in both periods. Hence, there is no reason to move from a cost-plus to a fixed-price contract over time.<sup>23</sup> Such evidence thus suggests that full commitment does not adequately describes the real world scenario of interest for this paper.

The optimal subsidy  $b^F$  increases with  $k$  and  $\alpha$ . Intuitively, when effort has a greater social value or when the operator's rent has more weight in the public authority's objectives, the optimal subsidy under a fixed-price contract must be raised to induce more firms to operate under higher powered incentives which command more rent.

## B Renegotiation

**Overview and modeling choices.** The full commitment assumption does not capture real-world practices as we explained above. Although the 1993 Law invites local authorities to re-auction concession contracts for a fixed period of 5 years, these authorities are either reluctant to really implement the law or do not have enough expertise to launch complex calls for tenders. In practice, local authorities consider the requirement of re-auctioning the contract at fixed dates as the opportunity to renegotiate a contract with the incumbent (the so-called '*opérateur historique*') instead of really contemplating the possibility to contract with a new operator.

Contract theory has distinguished between two kinds of paradigms when it comes to model intertemporal contracting under limited commitment. The first concept allows for long-term contracts which can be renegotiated if par-

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<sup>23</sup>This justifies our initial focus on the binary choice between a long-term fixed-price and a long-term cost-plus contract and explains why we did not consider more complex patterns with cost-plus contracts followed by fixed-prices for instance. These profiles are suboptimal under full commitment although they are attractive under limited commitment.

ties find it attractive.<sup>24</sup> The second paradigm considers instead that only short-term contracts can be enforced.<sup>25</sup> Although contracts in the French transportation sector have a limited duration, the second of these paradigms does not capture the kind of relational contracting that characterizes a long-lived relationship between a local authority and its ‘opérateur historique’. The first paradigm better fits evidence, although it must be adapted to take into account that, even though a long-term contract cannot be signed, the promise of future recontracting is sufficiently credible. The renegotiation paradigm can then be replaced by a ‘re-negotiation’ view of contracting that, although technically similar, captures somewhat different real-world practices.

The selection of a contract within the simple two-item menu at the early contracting stage reveals information on the firm’s type. Choosing a fixed-price contract is interpreted by the principal as being ‘good news’ since it signals that the firm’s innate efficiency parameter  $\theta$  is low enough. Instead, choosing a cost-plus contract is ‘bad news.’ In a dynamic environment, information on costs is revealed over time and the principal would like to draft new agreements that incorporate such information. Renegotiating towards a second-period fixed-price contract with a large subsidy allows operators who have revealed not to be very efficient earlier on by choosing a cost-plus contract in the first period to reap productivity gains later on. Such large subsidies might thus be viewed as *ex post* attractive from the principal’s viewpoint.

**Contracts.** To build a model that fits with the contracting patterns which are actually found in our data set, we allow the principal to offer three possible options: A two-period fixed-price contract, a first-period cost-plus con-

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<sup>24</sup>Dewatripont (1989), Laffont and Tirole (1993, Chapter 10), Hart and Tirole (1988), Rey and Salanié (1996).

<sup>25</sup>Guesnerie, Freixas and Tirole (1985), Laffont and Tirole (1993, Chapter 9).

tract followed by a second-period fixed-price and a two-period cost-plus contract. Let us index by  $j = G, I, B$ , respectively these three scenarios. Let also denote respectively by  $C_1^0 = (b_1, b_2^0)$ ,  $C_2^0 = (\theta, b_3^0)$  and  $C_3^0 = (\theta, \theta)$ , the operator's payments under each scenario, and by  $C^0 = (b_1, b_2^0, b_3^0)$  the overall menu of fixed prices.

**Equilibrium concept.** In a *cut-off equilibrium*, the most efficient types belonging to a lower tail interval  $\Theta_G$  follow history  $G$ , whereas intermediate and least efficient ones belonging respectively to the middle interval  $\Theta_I$  and to the upper tail interval  $\Theta_B$  follow histories  $I$  and  $B$ .

An *almost* perfect Bayesian equilibrium (in short equilibrium) of the contractual game consists of the following strategies and beliefs:

- **Principal's strategy.** The principal offers the menu  $C^0$  at date 1, but might propose a renegotiation  $\tilde{R} = (\tilde{C}_2, \tilde{C}_3) \equiv (\tilde{b}_2, \tilde{b}_3)$  at date 2. That offer might supersede  $C^0$  date 2-continuation  $R^0 = (b_2^0, b_3^0)$ . The second-period subsidy (either  $\tilde{b}_2$  or  $\tilde{b}_3$ ) is offered once the principal has already updated beliefs over the operator's type following his first-period choice to operate under a fixed-price or a cost-plus. Of course, the operator only accepts renegotiated subsidies that increase his payoff.
- **Agent's strategy.** Because the operator anticipates (perfectly in equilibrium) the second-period subsidies  $R = (b_2, b_3)$  that follow renegotiation, we get the following contracting pattern.

1. Types in  $\Theta_G = \left[ \theta, b_1 + k + \frac{1-\beta}{\beta}(b_2 - b_3) \right]$  already adopt contract  $C_1^0$  anticipating that  $b_2^0$  and  $b_3^0$  will be respectively renegotiated to  $b_2$  and  $b_3$ . The cut-off type  $\theta_1^* = b_1 + k + \frac{1-\beta}{\beta}(b_2 - b_3)$  is just indifferent between choosing a two-period fixed-price contracts with subsidies  $(b_1, b_2)$  and moving from a first-period cost-plus contract to a second-period fixed-price contract with subsidy  $b_3$ .

2. Types in  $\Theta_I = [b_1 + k + \frac{1-\beta}{\beta}(b_2 - b_3), b_3 + k]$  choose contract  $C_2^0$  with the same expectations than above. The cut-off type  $\theta_2^* = b_3 + k$  is just indifferent between moving from a cost-plus to a fixed-price contract with subsidy  $b_3$  and operating under a cost-plus contract over both periods.
3. Types in  $\Theta_B = [b_3 + k, \bar{\theta}]$  choose a two-period cost-plus contract  $C_3^0$  anticipating that the renegotiated fixed prices won't be attractive for them anyway.

To illustrate, if the cut-off type  $\theta_1^*$  is just indifferent between adopting fixed prices in both periods or only at date 2, more efficient types, such that  $\theta \leq \theta_1^*$ , certainly also prefer to operate under fixed-price contracts over both periods.

**‘Almost’ equilibrium and limited updating.** Before renegotiation, the principal updates his beliefs using only the information that is revealed by the firm's first-period choice between operating under a fixed-price or a cost-plus contract. This is a slight departure away from full rationality to the extent that the principal could have used the more precise information contained in the realized first-period costs if the firm had operated under a cost-plus contract. This justifies the use of the qualifier ‘almost’ for our notion of equilibrium.<sup>26</sup>

**Renegotiation-Proofness Principle.** The theoretical literature on renegotiation has shown that focusing on renegotiation-proof mechanisms which come unchanged through the renegotiation process is without loss of generality. Any long-term agreement which is renegotiated could be replaced by another long-term contract with a second-period continuation equal to the renegotiated offer. This continuation cannot be superseded by another

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<sup>26</sup>Relying on such ‘almost’ rational principal is of course a methodological simplification. With this simplified view of updating, our model keeps then all the flavor of the dynamic rent/efficiency trade-off familiar from the theoretical literature on renegotiation.

contract; otherwise, it would not have been optimal to offer such contract at the renegotiation stage in the first place. Our focus on renegotiation-proof profiles of subsidies follows this logic.<sup>27</sup>

**Renegotiation-proof profiles.** Those profiles are characterized by the simple condition that the principal does not find attractive to raise subsidies at the renegotiation-stage. In the online Appendix, we show that a menu of contracts  $C = (b_1, b_2, b_3)$  is renegotiation-proof if it satisfies:

$$(2) \quad kf(b_3 + k) - \left(1 - \frac{\alpha}{1 + \lambda}\right) \left(F(b_3 + k) - F\left(b_1 + k + \frac{1 - \beta}{\beta}(b_2 - b_3)\right)\right) \leq 0.$$

Condition (2) expresses the fact that the principal does not find attractive to raise second-period subsidy if the firm has already proved having an intermediate type by taking contract  $C_2^0$ . The efficiency gains obtained by slightly increasing the subsidy  $b_3$  to attract a less efficient operator who initially thought about operating under  $C_3^0$  should be less than the net cost of raising the rent of all inframarginal types who already chose  $C_2^0$  but enjoy now that greater subsidy. Indeed, when  $b_3$  is increased by a small amount  $db$ , the marginal type  $\theta_2^*$ , who is just indifferent between taking the two-period cost-plus contract and a fixed-price contract for the second period only, slightly moves up and an extra mass of less efficient types  $f(b_3 + k)db$  brings efficiency gains of size  $k$ . On the other hand, information rents in-

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<sup>27</sup>This theoretical literature focuses on discrete types distributions. Working with a continuum is necessary to take into account the significant heterogeneity in costs realizations that is found in our data set. It also allows us to divide the types space into three intervals  $\Theta_G$ ,  $\Theta_I$  and  $\Theta_B$  whose respective measures (obtained from the equilibrium behavior of cut-off types that define those intervals) can be matched with the empirical distribution of observed behaviors. Models with discrete types might allow a more detailed analysis of the pattern of information revelation and are thus attractive from a theoretical point of view. However, such models would not explain well our data set.

crease for all types in  $\Theta_I$  and that cost is proportional to the measure of that set, namely  $(F(b_3 + k) - F(\theta_1^*)) db$ .

**Optimal renegotiation-proof menus of contracts.** Optimizing the principal's expected intertemporal welfare subject to the renegotiation-proofness constraint (2), we find:

**Proposition 2** *The optimal renegotiation-proof menu of contracts  $C^R = (b_1^R, b_2^R, b_3^R)$  is such that the two-period fixed-price contract entails a constant subsidy,  $b_1^R = b_2^R = \underline{b}^R$ , which is lower than the subsidy  $b_3^R = \bar{b}^R$  offered when a fixed-price contract is chosen for the second period only:*

$$(3) \quad \bar{b}^R > \underline{b}^R.$$

*The renegotiation-proofness constraint (2) is binding:*

$$(4) \quad kf(\bar{b}^R + k) = \left(1 - \frac{\alpha}{1 + \lambda}\right) \left(F(\bar{b}^R + k) - F\left(\underline{b}^R + k + \frac{1 - \beta}{\beta}(\underline{b}^R - \bar{b}^R)\right)\right).$$

To understand the intuition behind (3), notice that the renegotiation-proofness constraint (2) is relaxed when the probability of having a type in  $\Theta_I$  (i.e. the difference  $F(b_3 + k) - F\left(b_1 + k + \frac{1 - \beta}{\beta}(b_2 - b_3)\right)$ ) increases. Intuitively, if there are enough types in that interval, it becomes relatively costly to offer a subsidy  $\tilde{b}_3 \geq b_3$  at the renegotiation stage. Efficiency gains associated to such increase are then lower than the increase in the information rents distributed to all types in such interval  $\Theta_I$ . An increase in the probability  $F(b_3 + k) - F\left(b_1 + k + \frac{1 - \beta}{\beta}(b_2 - b_3)\right)$  is obtained by committing to a large  $b_3$  and low values for  $b_1$  and  $b_2$  that are not renegotiated. Finally, because the cut-off type  $\theta_1^*$  depends only on the discounted subsidy  $b_1 + \frac{1 - \beta}{\beta}b_2$ ,  $b_1$  and  $b_2$  must be reduced by the same amount. For the two-period fixed-price contract, subsidies remain constant over time.

Our model predicts thus an increasing profile of subsidies in the following sense: Types who choose only a fixed-price contract for the second period receive greater subsidies than those who choose fixed-price arrangements earlier on.

### III Empirical Model

We now turn to the empirical part of our analysis. Our objective is to assess the welfare gains that could be obtained if parties to the contract could instead commit to long-term contracts. To do so, we need to simulate an hypothetical situation of perfect commitment, conditional on the current ingredients of the regulation of the French public transportation industry under limited commitment. These ingredients are unknown to the econometrician and need to be estimated. We explain here how to recover these ingredients and we discuss the estimation results.

The estimation strategy is organized as a three-step procedure. We first focus on the menus of contracts faced by the operators. As we only observe the subsidies paid to the firms, we miss at least one item of the menu ( $\underline{b}^R$ ,  $\bar{b}^R$  or both, depending on which contractual arrangement is observed). The missing items need therefore to be recovered. In a second step, we estimate the ingredients of the model which are specific to the operator. Given the menu of contracts, the operator chooses the contract that maximizes his payoff. We use information on the contract choice, on the observed and estimated subsidies, as well as several characteristics of the operator obtained from our database to identify the distribution of the efficiency parameter  $\theta$  and the social value of effort  $k$ . Finally, we recover the missing elements that characterize the regulator's objective function. To do so, we focus on the optimality conditions induced by Proposition 2.



Before turning to the empirical model itself, we present in the next section our data and the different variables of interest. We explain throughout each step of the empirical analysis how we organize our dataset for the estimation. In particular, we define precisely which period and which network are selected in each case.

## A Data

Table 1 presents statistics on the different variables available in our data set. To understand how contracts are designed by public authorities and how operators choose those contracts, we gather observations on subsidies. Such information is required to recover the distribution of the efficiency parameter. Subsidies entail all payments to the operator, either at the beginning of the production process which are needed to reimburse expected costs (in the case of fixed-price regimes), as well as payments to the operator at the end of the contracting period to guarantee full reimbursement of total operating costs (in the case of cost-plus contracts).

Recall that our theoretical model makes the accounting simplification that commercial revenues are kept by the public authority and that costs are reimbursed to the operator. In our data, however, observed subsidies are the differences between expected or final costs and commercial revenues. To make our data coincide with the model, we add commercial revenues to the observed subsidy. Finally, we distinguish between nominal and real terms. Subsidies are deflated using consumer price indexes (all items) for France. Only real subsidies are used during the estimation process.

The characteristics of the operators include the size of the network (measured in kilometers), the number of lines operated, the size of the rolling stock (measured by the number of vehicles), the share of the labor bill in total costs, the share of drivers or engineers in the total labor force, and the

identity of the industrial group which owns the operator (Keolis, Transdev, Agir, or Connex). We thus assume that some firms are more likely to perform efficiently than others due to intrinsic advantages of larger stakes, size, managerial practices and concentration of skills.

Institutional variables describing the public authority comprise the number of cities involved in organizing the service, population size for the total urban area where the service is provided, and the political preference of the local regulator. As explained before, the urban network may include several municipalities. We observe the number of cities in each urban area as well as the total population of these areas. We also construct a dummy variable that takes value one if the local government is right-wing, and zero when it is left-wing.<sup>28</sup> Over the period of investigation, local governments may belong to one of the main political groups, ranked according to their position on the political line from extreme right to extreme left (Extreme Right, Right, Center Right, Left, and Extreme Left). We restrict the political landscape to two groups, i.e., left-wing, and right-wing.

Our raw dataset includes 49 networks observed over the 1987-2001 period. As each contractual period lasts for 5 to 6 years, although there are some exceptions and some missing data, we observe series of 3 contracts per network in most cases. Hence, our initial database contains 136 contracts in

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<sup>28</sup>Data on political preferences are published by the French national newspaper *Le Figaro*.

total.<sup>29, 30</sup>

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<sup>29</sup>To make our dataset consistent with our (two-period) theoretical model, we structure our sample in the following way: If a series of fixed-price regimes or a series of cost-plus regimes is considered, we keep all the contractual periods under scrutiny for our empirical analysis, given that the subsidies are constant from one period to another; hence, we may use series of three or more contracts in this case. Now, when considering series where a fixed-price regime is implemented after a cost-plus, we restrict our attention to contractual arrangements which start after the arrival of a new local government. In this case, a cost-plus is followed by one fixed-price or a series of fixed-price contracts. As a result, the sample which is considered for the estimation entails 117 contracts.

<sup>30</sup>Note that one contract in one network should in principle correspond to a unique observation in our empirical model, i.e., the contract items should remain constant over the - say - 5 years of a contract length. The data reality may be slightly different. In practice, the data set shows that over a single contract period, many items may be affected by small fluctuations. This may for instance be the case of the operator's supply measured by the number of seat-kilometers available, which, in turns, makes the costs and subsidy levels fluctuate too. These fluctuations follow from exogenous shocks that may affect the activity of the operator over the contract length and are assumed to be i.i.d. in our model: changes in traffic conditions, changes in network configuration, road constructions which may cut a service route over a certain period, and strikes are all such examples. The economic responses to these predictable shocks are written in the contract. Hence, although some items may fluctuate over the contract period, they pertain to the same contract. Instead of calculating a simple average value of each item over the contractual period when fluctuations are present, we choose to treat each contract-year as a separate observation so that the number of degrees of freedom of our study is increased. This is why the number of observations (579) is much larger in practice than the number of contracts.

## B Step 1. Menus of Contracts: Recovering Missing Subsidies

A scenario with limited commitment corresponds to different observations with series of fixed-price contracts, cost-plus contracts, or cost-plus contracts followed by fixed-price contracts. The efficiency parameter  $\theta$  of each operator, and therefore the subsidies  $\underline{b}^R$  and  $\bar{b}^R$  of the proposed menu affect its choice of contract. A renegotiation-proof scenario corresponds to the following possibilities.

- A series  $FF$  of fixed-price contracts over several contracting periods. The operator is rather efficient ( $\theta \leq \theta_1^* = \underline{b}^R + k + \frac{1-\beta}{\beta}(\underline{b}^R - \bar{b}^R)$ ).
- A cost-plus contract followed by a fixed-price contract ( $CF$  herein). The operator is only mildly efficient ( $\theta_1^* \leq \theta \leq \theta_2^* = \bar{b}^R + k$ ).
- A series of cost-plus contracts ( $CC$  herein). The operator is rather inefficient ( $\theta \geq \theta_2^*$ ).

To exploit the two cut-offs  $\theta_1^*$  and  $\theta_2^*$  and recover the distribution of  $\theta$ , we need to observe the subsidies ( $\underline{b}^R$  and  $\bar{b}^R$ ) specified in the optimal menu of contracts. Unfortunately, our data do not allow us to observe all subsidies included into a renegotiation-proof menu. Instead, only the actual subsidies paid to the operators are available. Hence, if the contractual arrangement is respectively

- $FF$ , we observe  $\underline{b}^{FF}$  directly in the data and we need to recover  $\bar{b}^{FF}$ ,
- $CF$ , we observe  $\bar{b}^{CF}$  directly in the data and we need to recover  $\underline{b}^{CF}$ ,
- $CC$ , we need to recover  $\bar{b}^{CC}$ .

**Estimation.** We propose to recover the missing variables  $\bar{b}^{FF}$ ,  $\underline{b}^{CF}$ , and  $\bar{b}^{CC}$  empirically. In municipality  $i$ , we expect subsidies to depend on a set  $Y$  of characteristics of the public authority, the operator, and the transportation

service itself. We write:

$$(5) \quad \underline{b}_i^R = \underline{B}(Y_i, \tau) + \epsilon_i,$$

$$(6) \quad \overline{b}_i^R = \overline{B}(Y_i, v) + \varkappa_i,$$

where  $\epsilon_i$  and  $\varkappa_i$  are two error terms. The *engineering* relationships between the set of variables  $Y_i$  and each level of subsidy  $b_i$  are identified through two distinct vectors of parameters  $\tau$  and  $v$ , which have to be estimated. We thus expect to identify two distinct marginal impacts of a given characteristic on the choice of  $\underline{b}^R$  and  $\overline{b}^R$ . According to our theoretical model, we need to check that  $\underline{b}_i^R < \overline{b}_i^R$ . We verify *ex post*, i.e., on our estimates, that these inequalities hold.

The estimation procedure works as follows. (i) If we select in our dataset *FF* arrangements only, the observed subsidies are the  $\underline{b}_i^R$ . Using observations  $Y_i^{FF}$  related to these specific arrangements, we obtain maximum likelihood estimates of  $\tau$ . We then derive the value  $\widehat{\underline{b}}_i^{CF}$  using our estimates  $\tau$  and a set of characteristics  $Y_i^{CF}$  if a *CF* arrangement is instead considered. (ii) Likewise, if we select in our dataset the fixed-price contracts of the *CF* arrangements only, the observed subsidies are the  $\overline{b}_i^R$ . Using observations  $Y_i^{CF}$  for these specific arrangements, we obtain maximum likelihood estimates of  $\varkappa$ . We then derive the value  $\widehat{\overline{b}}_i^{FF}$  (resp.  $\widehat{\overline{b}}_i^{CC}$ ) using our estimates  $\varkappa$  and a set of characteristics  $Y_i^{FF}$  (resp.  $Y_i^{CC}$ ) if a *FF* (resp. *CC*) arrangement is considered.<sup>31</sup>

**Data selection.** From the reduced sample, selecting *FF* arrangements only yields a subsample of 54 fixed-price contracts, i.e., 300 contract-years. Likewise, when keeping the fixed-price contracts of the *CF* arrangements only, we obtain a subsample of 23 fixed-price contracts, i.e., 93 contract-years.

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<sup>31</sup>For ease of exposition, we omit the labels *FF*, *CF*, or *CC* in what follows.

**Results.** We assume a linear relationship between a subsidy level and a set of characteristics  $Y_i$  in equations (5) and (6). The characteristics we focus on are related to the regulator, the operator, or the network. These are the size of the rolling stock, the size of the transport network, the share of the labor bill in total costs, a dummy variable which takes value one if the local government is right-wing, and zero otherwise, a dummy variable that takes value one if the operator belongs to Keolis (Agir or Connex respectively) and zero otherwise. We also introduce operators' fixed effects given that several contract-years are observed for the same operator.

Results are presented in Table 2. Unsurprisingly, each subsidy level increases with the volume of the rolling stock, or the network size. However, the network size is a more important factor to explain the first-period subsidy  $\underline{b}^R$ , compared to  $\bar{b}^R$ , while the second-period subsidy  $\bar{b}^R$  seems to be more sensitive to fluctuations in the rolling stock. Subsidies decrease if the share of labor in total operating expenses increases. Likewise, the right-wing variable has a negative and significant sign;<sup>32</sup> note that the right/left margin is more pronounced when it comes to explaining  $\bar{b}^R$  compared to  $\underline{b}^R$ . Moreover, our results suggest that the group that owns the operator matters as well. Operators owned by Agir tend to receive lower subsidies compared to operators of other groups. Likewise, operators owned by Keolis receive higher  $\underline{b}^R$  and lower  $\bar{b}^R$ .

In Table 3, we present the average value and the standard deviation of the estimated  $\hat{\underline{b}}^R$  and  $\hat{\bar{b}}^R$  for all contract-year of the reduced sample. A simple t-test confirms that both quantities are statistically different from each other. Moreover,  $\hat{\underline{b}}^R < \hat{\bar{b}}^R$  as expected.

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<sup>32</sup>This outcome is ambiguous since it is difficult to disentangle the right-wing effect from other factors which are proper to right-wing governments; in particular, right-wing municipalities have a significant preference for fixed-price contracts and this may explain why subsidies are lower in this case.

## C Step 2. Contract Choice

We recover now the distribution of types by matching the theoretical probabilities of the three observed contractual regimes  $FF$ ,  $CF$  and  $CC$  being chosen with their empirical probabilities. To do so, we take a parametric approach and assume that the distribution  $F(\cdot, \nu_{lc}, \sigma_{lc})$  is normal with mean  $\nu_{lc}$ , variance  $\sigma_{lc}$  and density  $f(\cdot, \nu_{lc}, \sigma_{lc})$ .<sup>33</sup>

**Data selection.** To compute the distribution of  $\theta$ , we use all contracts of our reduced dataset since we look for the probabilities of choosing one series of contracts among all possible arrangements. We thus consider 117 contracts, i.e., 579 contract-years.<sup>34</sup>

**Estimation.** We assume that the  $\theta_i$ s are independent draws from a normal distribution that is common across networks.<sup>35</sup> The operator accepts a fixed-price contract in both periods when  $\theta_i \leq \theta_{1i}^* = \underline{b}_i^R + k + \frac{1-\beta}{\beta}(\underline{b}_i^R - \hat{\underline{b}}_i^R)$  so that

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<sup>33</sup>Our theoretical model assumes a finite support for the distribution of innate costs. It avoids negative cost parameters. In our empirical analysis, those events have very low probabilities and we simplify the analysis by using normal distributions. Using a normal distribution ensures that our estimated distribution has short flat tails, i.e., a very small share of the operators lies in the tails of the probability distribution. Using distributions on bounded intervals, such as the Beta or the truncated normal, may be problematic. A Beta-distribution would impose a strong normalization on costs, which is potentially damageable for the relevance of our structural model. At the same time, identifying the additional parameters of a truncated normal is not feasible with our data.

<sup>34</sup>See above footnotes 29 and 30.

<sup>35</sup>Attempts to identify fixed effect in our structural model through fixed-effect dummy variables have been unfruitful. Note however that our structural model heavily relies on  $k$ , the social value of effort, which itself depends on a set of explanatory variables, the operator's group identity, the size of the network, and the share of engineers in the labor force. The group identity variable is the group fixed effect while the two latter variables are quite stable over time and can therefore be reasonably expected to capture firms fixed effects.

the probability of accepting such fixed-price contract is:

$$(7) \quad \Pr(\theta_i \leq \theta_{1i}^*) = F\left(\underline{b}_i^R + k_i + \frac{1-\beta}{\beta}(\underline{b}_i^R - \widehat{\underline{b}}_i^R), \nu_{lc}, \sigma_{lc}\right).$$

We consider here the pair  $\left(\underline{b}_i^R, \widehat{\underline{b}}_i^R\right)$  since the observed arrangement is  $FF$ . We allow the unobserved social value of effort  $k$  to vary across networks; it depends on a set of explanatory variables  $X_i$  which account for the characteristics of the operator:

$$(8) \quad k_i = k(X_i, \varphi),$$

where  $\varphi$  is a vector of parameters to be estimated.

The operator goes from a cost-plus to a fixed-price contract when  $\theta_{1i}^* \leq \theta_i \leq \theta_{2i}^* = \bar{b}_i^R + k_i$ . The probability of such pattern is thus:

$$(9) \quad \Pr(\theta_{1i}^* \leq \theta_i \leq \theta_{2i}^*) = F\left(\bar{b}_i^R + k_i, \nu_{lc}, \sigma_{lc}\right) - F\left(\widehat{\underline{b}}_i^R + k_i + \frac{1-\beta}{\beta}(\widehat{\underline{b}}_i^R - \bar{b}_i^R), \nu_{lc}, \sigma_{lc}\right).$$

We consider here the pair of subsidies  $\left(\widehat{\underline{b}}_i^R, \bar{b}_i^R\right)$  given a  $CF$  history.

Finally, the operator takes cost-plus contracts in both periods when  $\theta_{2i}^* = \widehat{\underline{b}}_i^R + k_i \leq \theta_i$ . The probability of accepting such arrangement is thus:

$$(10) \quad \Pr(\theta_{2i}^* \leq \theta_i) = 1 - F\left(\widehat{\underline{b}}_i^R + k_i, \nu_{lc}, \sigma_{lc}\right).$$

The log-likelihood of observing one specific contractual arrangement in network  $i$  over period  $t$  can be written as:

$$\begin{aligned} L_i(\nu_{lc}, \sigma_{lc}) = & \Delta_i \log \left( F\left(\underline{b}_i^R + k_i + \frac{1-\beta}{\beta}(\underline{b}_i^R - \widehat{\underline{b}}_i^R), \nu_{lc}, \sigma_{lc}\right) \right) + \\ & \Pi_i \log \left( F\left(\bar{b}_i^R + k_i, \nu_{lc}, \sigma_{lc}\right) - F\left(\widehat{\underline{b}}_i^R + k_i + \frac{1-\beta}{\beta}(\widehat{\underline{b}}_i^R - \bar{b}_i^R), \nu_{lc}, \sigma_{lc}\right) \right) \\ & + \Sigma_i \log \left( 1 - F\left(\widehat{\underline{b}}_i^R + k_i, \nu_{lc}, \sigma_{rp}\right) \right), \end{aligned}$$



where  $\{\Delta_i, \Pi_i, \Sigma_i\}$  are three dummies taking value one if the observed contractual arrangement is of type  $\{FF, CF, CC\}$  respectively, and zero otherwise.

Observations being independent, the log-likelihood for our sample is just the sum of all individual log-likelihood functions:

$$L(\mu_{lc}, \sigma_{lc}) = \sum_{i=1}^N L_i(\nu_{rp}, \sigma_{lc}).$$

**Results.** To estimate  $F(\cdot)$ , we need to determine which variables  $X$  affect the social value of effort  $k$ . Explanatory variables are related to the operator's characteristics (its skills and managerial ability, its effort technology). These variables are a constant, the total size of the service network in kilometers, the number of lines operated, the size of the rolling stock in number of vehicles, the share of the labor bill in total costs, the percentage of engineers in the total labor force, dummy variables taking value one if the operator belongs to Keolis (Agir or Connex, respectively) and zero otherwise.

Results are presented in Table 4. During the estimation, we realized that explanations for the social value of effort highly differ from one network to the other, i.e., we could not obtain unique significant effects for all operators. Hence, we allow estimation results to vary from one group to another. We present three different estimations.

In column (I),  $k$  depends on four dummy variables which account for the identity of the operator's group (Connex is the reference group). Only Transdev has a significant and positive effect on  $k$ , suggesting that an operator belonging to Transdev may guarantee a higher social return on effort compared to operators from other groups.<sup>36</sup> This result also suggests that

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<sup>36</sup>The social value of effort is negatively related to the technological cost of effort, which implies that Transdev also enjoys a less costly effort technology. It would be interesting to relate these findings to the internal structure of managerial incentives in that firm but

Transdev has preferences for fixed-price contracts as an increase in  $k$  increases the probability to choose a fixed-price regime. This pattern is well known by transport regulators in France.<sup>37</sup>

In column (II), the explanatory variables are a constant for each group and the size of the network interacted with each one of the group dummy variables. The results show that the size of the network significantly and positively affects the social value of effort in networks where Agir operates. This may illustrate that economies of scale in effort technology are greater for larger networks.

In column (III), the explanatory variables are a constant for each group and the share of engineers interacted with each one of the group dummy variables. The share of engineers provides a measure for the endowment of skills embodied in the firm. Engineers are generally responsible for research and development, quality control, maintenance, and efficiency. Their action is particularly important to improve the average speed of the network. We expect thus the share of engineers in the total labor force to positively affect the social value of effort. Instead, the results suggest ambiguous effects. If the operator belongs to Transdev, the share of engineers has the expected effect. If the operator belongs to Agir or Keolis, the effect goes in the opposite direction.

Other variables such as the number of lines operated, the size of the rolling stock, or the share of the labor bill in total costs have not given significant results. The three estimation procedures yield very similar estimates of  $\nu_{lc}$  and  $\sigma_{lc}$ , the mean and standard deviation of  $\theta$ 's normal distribution respectively. Our results are strongly significant and suggest that the average innate cost  $\theta$  varies between 14 and 15 millions Euros.

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we did not have access to such information.

<sup>37</sup>See the reports of the Groupement des Autorités Responsables de Transport (GART), <http://www.gart.org/S-informer/Publications-du-GART>).

We also obtain a direct estimate of the intertemporal weight  $\beta$ . Values are between 0.25 and 0.41, indicating that the second period is perceived as more important.

Finally, it is of interest to test whether our structural model for contract selection is useful and appropriate. To do so, we test our model against a simple ordered probit specification where the three contractual arrangements are chosen with probabilities  $\Pr(FF) = \Phi(-\delta X)$ ,  $\Pr(CF) = \Phi(\mu - \delta X) - \Phi(-\delta X)$ , and  $\Pr(CC) = 1 - \Phi(\mu - \delta X)$ ;  $\delta$  being a vector of parameters to be estimated together with  $\mu$ ,  $X$  being the set of the operator's characteristics described above, and  $\Phi(\cdot)$  being the c.d.f. of the normal distribution. Since the two models are non-nested, we use a test proposed by Vuong (1989). The null hypothesis is that both models are equally far from the true data generating process in terms of Kullback-Liebler distances. The alternative hypothesis is that one of the two models is closer to the true data generating process. When the Vuong statistics is less than 2 in absolute value, the test does not favor one model against the other. Here, the statistics of our structural model versus the ordered probit is 4.7. This strongly supports the structural approach presented in this paper.

## D Step 3. Political preferences

Once estimates  $\hat{\nu}_{lc}$ ,  $\hat{\sigma}_{lc}$ ,  $\hat{\beta}$  and  $\hat{k}_i$  are obtained, we evaluate the regulator's preference parameter  $\hat{\alpha}_i$ . To do so, we use the renegotiation-proofness condition (4) rewritten now as:

$$\begin{aligned}
 & -k_i f\left(\bar{b}_i^R + k_i, \nu_{lc}, \sigma_{lc}\right) \\
 (11) \quad & + \left(1 - \frac{\alpha_i}{1 + \lambda}\right) \left( F\left(\bar{b}_i^R + k_i, \nu_{lc}, \sigma_{lc}\right) - F\left(\bar{b}_i^R + k_i + \frac{1 - \beta}{\beta} (\bar{b}_i^R - \bar{b}_i^R), \nu_{lc}, \sigma_{lc}\right) \right) = 0,
 \end{aligned}$$

$$i = 1, \dots, N.$$

The weight  $\alpha_i$  varies across cities. It depends on a set of explanatory variables  $Z_i$  which characterize the local authority:

$$(12) \quad \alpha_i = \alpha(Z_i, \chi),$$

where  $\chi$  is a vector of parameters to be estimated.

We cannot identify separately the weight  $\alpha$  and the cost of public funds  $\lambda$  since only the ratio  $\frac{\alpha}{1+\lambda}$  matters in Equation (4). We will thus let  $\lambda$  take several values which are consistent with the cost of an administration operating in a developed country.<sup>38</sup> We only present estimation results when  $\lambda = 0.3$ . Alternative estimates of  $\alpha$  can easily be calculated when  $\lambda \neq 0.3$ .

**Data selection.** We restrict the reduced sample to fixed-price contracts only given that Proposition 2 is about short-term (the fixed-price contracts belong to a *CF* arrangement) and long-term (the fixed-price contracts belong to a *FF* arrangement) fixed-price regimes. This yields a subsample of 77 contracts, i.e., 393 contract-years.

**Estimation.** To obtain maximum likelihood estimates, Equation (11) is rewritten as

$$(13) \quad J(\underline{b}^R, \bar{b}^R, k_i, \alpha_i, \lambda, \nu_{rp}, \sigma_{lc}, \xi_i) = 0,$$

where  $\xi_i$  is an error term. We need again to distinguish between the observed and the estimated  $(\underline{b}^R, \bar{b}^R)$ . If the observed fixed-price contract is extracted

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<sup>38</sup>Ballard, Shoven and Whalley (1985) provided estimates (namely, 1.17 to 1.56) of the welfare loss due to a one-percent increase in all distortionary tax rates. (See also Hausman and Poterba, 1987, on this.) In the case of Canadian commodity taxes, Campbell (1975) found that this distortion is equal to 1.24. More generally, distortions fall between 1.15 and 1.40 in countries with an efficient tax system. Gagnepain and Ivaldi (2002) obtained a similar result in their study of the French transportation sector.

from a  $CF$  arrangement, we consider the pair  $(\widehat{\underline{b}}_i^R, \bar{\underline{b}}_i^R)$ . Otherwise, If the observed fixed-price contract belongs to a  $FF$  arrangement, we consider the pair  $(\underline{b}_i^R, \widehat{\bar{b}}_i^R)$ .

**Results.** The explanatory variables which enter  $Z_i$  are a constant, the number of cities within the local authority in charge of the service, the size of the population of the relevant urban area, and the local political preference.<sup>39</sup> With the first two variables, we want to test whether the size of the city or a greater division of the network into distinct urban areas affects the bargaining power of the operator. We expect the latter to be more important in small networks or networks made of many urban areas. With respect to the political preference of the local government, casual evidence suggests that a right-wing local government is more eager to favor private operators. The estimate  $\widehat{\alpha}_i$  should thus be higher with a right-wing local government.<sup>40</sup>

Results are presented in Table 5. First, the number of cities constituting the local authority and population size were not significant and have been discarded. Second, whether the government is right-wing or not has a positive and very significant impact on  $\alpha$ , confirming thereby our prior intuition. In this case,  $\alpha$  takes value 0 for left-wing local governments while it is strictly positive for the right-wing ones. Third, our initial restriction  $\alpha \leq 1 + \lambda$  holds, even though it is not imposed in the estimation.

A potential criticism of our three-step estimation procedure is that we may not fully account for the optimality conditions satisfied by  $\underline{b}^R$  and  $\bar{b}^R$  which are not part of the estimation process.<sup>41</sup> An alternative estimation procedure could consist in recovering values of  $(\underline{b}^R, \bar{b}^R)$  through the system

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<sup>39</sup>For local authorities made of several cities, the political preference is that of the main municipality.

<sup>40</sup>This point is corroborated in Levin and Tadelis (2009).

<sup>41</sup>See the proof of Proposition 2 in the online Appendix for expressions of those conditions.

made of those two optimality conditions plus the renegotiation-proofness constraint. Thus,  $\underline{b}^R(\cdot)$  and  $\bar{b}^R(\cdot)$  would be two functions of a set of variables and parameters to be estimated which we could use to write the log-likelihood of observing one specific contractual arrangement in a similar fashion as in Step 2. Although attractive, this alternative procedure suffers from a serious drawback in that it does not use our data observations of  $(\underline{b}^R, \bar{b}^R)$ . Using directly the data observations of  $(\underline{b}^R, \bar{b}^R)$  or recovering  $(\underline{b}^R, \bar{b}^R)$  through a system of optimality conditions would probably yield a similar outcome if our theoretical model perfectly explained the data reality, which is probably excessive. We therefore prefer to use the data information on  $(\underline{b}^R, \bar{b}^R)$ . To convince the reader that our approach is reasonable, we propose an ex post test to check that our estimates  $\hat{\nu}_{lc}$ ,  $\hat{\sigma}_{lc}$ ,  $\hat{\beta}$ ,  $\hat{k}_i$ , and  $\hat{\alpha}_i$  verify the conditions expressed in the equations (11) and (12) of the online Appendix; to do so, we replace  $\mu$  in (11) by its expression from (12) in order to generate an equation (11'). Then, we compute a  $t$ -test to check whether the left-hand side of equation (11') is significantly different from its right-hand side. We cannot reject the hypothesis that both sides are equal.

## IV The Welfare Gains of Commitment

We assess now the magnitude of the welfare gains which can be obtained once one moves from the renegotiation-proof setting to the less constrained full commitment scenario. We also investigate how these gains are distributed between private operators and taxpayers. This is an important issue for practitioners since they often have complained about the insufficient length of concession contracts in this sector.

Starting from our estimates of the various parameters of the model obtained from the renegotiation-proof scenario, we can reconstruct estimates

of the average social cost of subsidies and the average rent left to operators under full commitment.<sup>42</sup> We proceed as follows.<sup>43</sup>

**Data selection.** We restrict the reduced sample to  $FF$  arrangements only given that proposition 1 is about long-term fixed-price contracts. Moreover, we focus on right-wing networks only since we need  $\hat{\alpha}^R > 0$ . Once outliers are discarded, we obtain a subsample of 114 contract-years.

**Step 1.** Using our set of renegotiation-proof estimates  $\Upsilon^R = (\hat{\nu}^R, \hat{\sigma}^R, \hat{k}^R, \hat{\alpha}^R, \hat{\beta}^R)$  conditional on  $\lambda$  and its expression from the maximand in a scenario with limited commitment, we compute expected welfare levels  $\mathcal{W}_i^R$  for each network of our subsample. As emphasized throughout this section, the renegotiation-proof scenario corresponds to the actual contractual practices encountered in the French urban transport industry. Hence, the estimates  $\Upsilon^R$  give to the econometrician some information on the operator's and public authority's true characteristics.

**Step 2.** We simulate the hypothetical subsidy level  $\hat{b}_i^F$  that would be paid under full commitment. To do so, we solve (1) with respect to  $\hat{b}_i^F$ , using the real networks characteristics  $\Upsilon^R$ .

**Step 3.** We reconstruct the hypothetical welfare measures  $\hat{\mathcal{W}}_i^F$  for each network of our subsample, as predicted under full commitment, and using estimates  $\hat{b}_i^F$  and  $\Upsilon^R$ .

We compute the total welfare gains as well as the gains for taxpayers and operators from commitment by considering an average network of the subsample, using estimates  $\Upsilon^R$  conditional on  $\lambda = 0.3$  and  $k_i$  specified as in (II) in Table 4.<sup>44</sup>

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<sup>42</sup>Remember that our theoretical model has normalized the value of the service at some fixed level  $S$  so that consumers' gross surplus does not change when considering different regimes. This variable will thus be omitted in our analysis.

<sup>43</sup>See the online Appendix for details.

<sup>44</sup>Note that the final welfare results do not vary in a significant manner if other values

The estimates reported in Table 6 shed light on several interesting results. Of course, commitment always improves welfare compared to the situation where renegotiation puts further constraints on contracting. The important question is actually to determine how welfare gains of commitment are distributed between the parties. It turns out that  $\hat{T}_i^F > \hat{T}_i^R$ , i.e., switching from limited to full commitment entails a higher intertemporal subsidy. The intertemporal payment to the operator increases, on average, by 6.1 million Euros. Hence, taxpayers lose from an increase in the length of concession contracts, given that social costs increase by 8 million Euros (+22.4 percent) on average.

Turning now to operators, our estimates show that their intertemporal rent increases when moving to full commitment by 8.2 million Euros (+11.5 percent). This is a significant gain that explains why operators are pushing to increase contracts length.

## V Alternative Assumptions

Overall, the analysis above suggests that our structural model is a reasonable representation of the industry: We have provided a test which rejects a simple contract choice model with no asymmetric information parameters against our structural approach. The estimated parameters obtained from the empirical model are in general significant and have signs which go in the right direction. Moreover, although we do not impose any constraint on the estimation procedures, we do obtain estimates that are consistent with the assumptions of the theoretical model.

For the sake of completeness, this section nevertheless discusses alternative scenarios which could be relevant to explain our data, or which could be

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of  $k_i$  are chosen.



simulated using ingredients from our limited commitment model. Our goal here is to point out a few criticisms of those alternative explanations, to confirm the relevance of our focus on renegotiation as the main explanation of the contracting patterns found in the data set, and provide additional welfare measures for different contracting scenarios.

## A Evolving Bargaining Powers

The optimal subsidy given by (1) is greater when the operator’s bargaining power  $\alpha$  increases. This suggests that a pattern where greater subsidies are offered following an earlier cost-plus contract could also be replicated with the simpler assumption that bargaining powers evolve over time. More precisely, suppose that only short-term contracts can be signed but that innate costs are independent draws from the same distribution in each period. Subsidies in each period are still given by (1) with the added feature that  $\alpha$  is time-varying and increasing.

There are two issues with such a model. The first one is that it is difficult to understand why changes in  $\alpha$  would depend on the earlier history (fixed-price or cost-plus) and especially be more pronounced following a cost-plus contract as featured in our dataset. Indeed, economic theory suggests that changes in bargaining power could result from a more pronounced collusion between operators and public authorities, or from more symmetric stands following earlier sunk investments by operator. However, both collusion and sunk investments are facilitated when rents are high; a feature of fixed-price contracts. So if anything, the operator’s bargaining power should increase following fixed-price and not cost-plus contracts.

Second, we can construct a simple test of whether subsidies increase over time and whether this pattern is firm specific. If the bargaining power of an operator increased over time and affected subsidies, we should observe an

increase in the subsidy levels of the successive fixed-price contracts signed after a cost-plus regime for this operator. We add to the simple regression presented in Footnote 13 an interaction  $Trend \times CF$ , and three interactions  $Trend \times CF \times Firm_j$  where  $Firm_j$  is a dummy variable that accounts for the identity of the company which owns the observed operator. While the original parameters already presented in Footnote 13 are unchanged, none of the interactions has a significant impact on the observed subsidies, which suggests that an increase of the bargaining power of firms over time is unlikely.

## B Short-Term Contracts

An alternative, already investigated both in the theoretical and empirical literatures,<sup>45</sup> is to consider that the only feasible contracts are short-term. In the present context of the French transportation sector, we argued above that this scenario does not fit actual practices. Nevertheless, it is worth simulating the welfare impact of such stronger degree of contract incompleteness, much in spirit of Section IV. This allows us to compare welfare between full commitment, limited commitment, and no-commitment.

Let us briefly sketch how the contracting game unfolds with short-term contracts. In the first period, operators again select different contracts according to their innate costs. As before the most efficient firms choose a first-period fixed-price contract with subsidy  $b_1$  whereas the least efficient ones operate under a cost-plus contract. Before re-contracting, the principal updates his beliefs on the operator's cost parameter according to whether a fixed-price or a cost-plus contract has been chosen.<sup>46</sup>

To make comparison between the cases of short-term contracting and

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<sup>45</sup>See respectively Laffont and Tirole (1993, Chapter 9) and Dionne and Doherty (1994).

<sup>46</sup>As in our main renegotiation scenario, we assume that, had a cost-plus been chosen, the exact realization of those costs would not be used to update the principal's beliefs.

renegotiation more meaningful, we focus on equilibria with short-term contracts which generate the three patterns observed in our data: Fixed-price or cost-plus contracts over both periods, or a cost-plus followed by a fixed-price contract. Following our earlier notations, a profile of subsidies  $(b_1, b_2, b_3)$  is offered at the different points in time along the different histories. Of course, the principal chooses a first-period subsidy that determines the first-period cut-off with an eye on how it affects the continuation of the contracting game. In particular, following an earlier choice of a cost-plus contract and thus knowing that the operator's type is greater than  $\theta_1^*$ , the optimal second-period subsidy  $b_3$  must be conditionally optimal given the principal's updated beliefs:

$$(14) \quad kf(b_3 + k) = \left(1 - \frac{\alpha}{1 + \lambda}\right) (F(b_3 + k) - F(\theta_1^*)).$$

This 'conditional optimality' expresses the fact that, in choosing the second-period subsidy, the principal trades off the extra cost in terms of extra rents and the efficiency gains of offering a greater subsidy  $b_3$  for a subset of types who operated earlier on under a cost-plus. This condition is very similar to the binding renegotiation-proofness constraint (2) up to a (possibly) different value for the first-period cut-off  $\theta_1^*$ . The main difference between the no-commitment and the renegotiation-proof scenarios comes instead following the earlier choice of a fixed-price contract. The principal then knows that the firm is rather efficient and has thus incentives to cut down second-period subsidies; a well-known instance of the 'ratchet effect'. More formally, if type  $\theta_1^*$  is indifferent between a fixed-price and a cost-plus contract in the first period and chooses a fixed-price, it will receive only a low subsidy  $b_2$  such that  $\theta_1^* = b_2 + k$  in the second period while choosing a cost-plus in the first period would have secured more rent later on through increased subsidies. This subsidy  $b_2$  extracts all second-period rent from that cut-off type. With short-term contracts, the principal cannot make any credible promise to reward operators who choose earlier on a fixed-price contract with

some extra rent later on. As a result, subsidies are decreasing over time in the sense of having  $b_2 < b_1$ .<sup>47</sup> This is in contrast with what we observe in our data and what an optimal renegotiation-proof profile predicts. In that case, the principal can smooth the rewards for choosing earlier to operate under a two-period fixed-price contract with subsidies which are constant over time.

Turning to the empirical analysis, we simulate the welfare obtained with this short-term contract scenario and our data. The empirical strategy is similar to the one presented in Section IV. Starting from our estimates of the various parameters of the model obtained from the renegotiation-proof scenario, we can reconstruct estimates of the cut-offs  $\theta_1^*$ ,  $\theta_2^*$ , and  $\theta_3^*$  that delineate the various first-period scenarios. The corresponding subsidies and the value of welfare are then easily computed. The empirical results suggest that moving to short-term contracts deteriorates welfare compared to limited commitment. For the average network, the welfare difference between the full and limited commitment scenarios is 0.53 million euros while the welfare difference between the full and no-commitment cases is 1.26 million euros.<sup>48</sup>

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<sup>47</sup>See the online Appendix for details.

<sup>48</sup>These welfare differentials cannot be directly compared to the ones presented in Table 6 for two reasons: First, these simulations are computed with a smaller database than the one used in Section 4. Second, these statistics are provided as an empirical illustration of our theoretical proposal on short-term contracts but should not be taken as the true features of the industry. Indeed, as emphasized in our online Appendix, our model of short-term contracting requires  $\beta \geq \frac{1}{2}$  to replicate the same contracting sequences than under renegotiation. This contradicts our empirical findings that  $\beta < \frac{1}{2}$  in that case, as shown in Table 4. In reality, operators are more patient than what our theoretical model predicts because the operators' time horizon probably goes beyond the two periods considered in our theoretical framework. To perform our simulation exercise, we keep the original ingredients of the model obtained from the renegotiation-proof scenario, but we use an ad hoc value  $\beta = 0.6$  for the three scenarios of full, limited, and no-commitment.

## VI Conclusion

We have developed a principal-agent model under limited commitment that features the main characteristics of contracts and institutional practices in the French urban transportation sector. On top of estimating key parameters of the economic and political landscape in this sector, this model has allowed us to evaluate the cost of renegotiation and how welfare gains would be redistributed by increasing contract duration and improving commitment. The welfare gains from extending contract length are significant but mostly accrue to operators.

Our analysis, however, calls for a few remarks and alleys for further investigation.

First, our result on the significant welfare gains of extending contract length should be taken with some words of caution. Indeed, it starts from the premise that, in this sector, competition is almost absent at the bidding stage. We are thus examining the benefits of such reform in a monopolistic setting where more competition could even bring higher welfare gains. However, extending contract length might not favor the emergence of a more competitive playing field which may reduce long-run welfare.

By focusing on menus with only two items (fixed-price and cost-plus contracts) whereas a model with a continuum of types might invite more complex contracts and by simplifying the procedure for updating beliefs, we have significantly simplified our theoretical model. The benefit is that we were able to bring the lessons of the renegotiation literature to the data. Taking data and institutional constraints seriously forced us instead to focus on the case of simple menus which, although suboptimal, brings also some tractability. This approach might also be fruitful in other contexts where full-fledged theoretical models become non-tractable.

Even though our estimates are significant, we might be underestimating the welfare gains of commitment. Indeed, we have no ideas on how renegotiation weakens the operator's incentives to make relationship-specific investments except through informal talks with practitioners in the field. Introducing these considerations would reinforce our argument in favor of extending contract length. Longer contract durations would indeed secure specific investments and avoid hold-ups.

On the other hand, one could also argue that even writing a long-term contract may entail significant transaction costs, especially when future contingencies cannot be perfectly foreseen *ex ante*. In our model, such transaction costs have deliberately been omitted since we focused on stationary environments where efficiency parameters are drawn once for all. Introducing the possibility of writing more flexible contracts as uncertainty gets resolved would unveil some interesting benefits of renegotiation. On top, the need for drafting flexible arrangements may also favor fixed-price contracts since those contracts make operators more reactive to shocks affecting their costs. Yet, it is unclear to us whether those theoretical arguments in favor of some kind of limited commitment matter in the transportation sector under scrutiny.

A more complete analysis of the renegotiation process should incorporate the possibility that public authorities build reputations for being tough at the renegotiation stage to avoid thereby giving larger subsidies to operators. Reputation building might significantly relax renegotiation-proofness constraints. In other words, an omitted variable of our analysis is the amount of reputational capital available to the contracting parties involved in those repeated negotiations. By putting reputation aside, we have thus analyzed a 'worst scenario' under renegotiation. More research both on the theory side but also in building data sets which could account for that reputational capital is certainly called for.

Our estimation has highlighted a few systematic differences between oper-

ators of different companies in their abilities to generate social value through managerial efforts. It would be worth linking those different abilities to the internal organizations, the management practices and incentive structures of those firms. At this stage, we have no information on those variables.

Other weaknesses of our analysis could be improved in the future: While our cost function is tractable enough to develop the theoretical model, it may reasonably raise concerns on the predictability of the estimated model. More flexible functional forms and/or non-parametric techniques could be investigated. Note also that our simulations of the full commitment or no-commitment cases assume that the current ingredients of the industry are unchanged. This assumption could be relaxed; we could for instance expect that the distribution of the innate costs is different under a full commitment scenario if new operators with different cost characteristics enter the market (knowing that regulatory rules are modified). We have currently no theoretical justification to offer to describe such changes but further investigation in this direction is indeed welcome. We have also noted that the industry has changed significantly after 2001. In particular, movements of operators from one network to another have been observed. Modeling the strategic behavior of operators in competitive tendering is an interesting topic that needs to be addressed as well.

Lastly, our estimate of the cost distribution allows us to ascertain whether the restriction to simple menus matters even in a static context. Echoing the theoretical works of Rogerson (2003) and Chu and Sappington (2007), we could indeed ask whether simple two-item menus fare well compared with more complex menus given our estimate of the types distribution. Such investigation would unveil whether the major sources of benefits in contract design come either from extending contract length or from better designing cost reimbursement rules in any given period. This last issue is high on practitioners' agenda.

We hope to investigate some of those issues in future research.



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Table 1: Data

<b>Variables</b>	<b>Mean</b>	<b>Stand. Dev.</b>
Nominal Subsidy (Euros)	20,702,141	19,239,199
Including Revenue (Euros)	9,608,629	10,526,903
Subsidy per unit of supply (Euro)	0.016	0.005
Real Subsidy (Euros)	18,760,150	17.395,482
Size of the network (km)	288.3	200.1
# of lines	23.6	13.2
# of vehicles	168.1	119.5
# of cities in the urban network	18.3	16.7
Size of population	236,799	177,641
Share of Labor in total costs	0.64	0.10
Share of engineers	0.29	
Share right-wing government	0.52	
Share Fixed Price contracts	0.55	
Share Keolis	0.32	
Share Agir	0.16	
Share Connex	0.22	
Share Transdev	0.24	

Table 2: Estimated Subsidies I

Variables	$\underline{b}$		$\bar{b}$	
	I	II	I	II
Constant	6.17*** (0.38)	6.39*** (0.29)	7.15*** (0.30)	7.49*** (0.33)
Rolling Stock	0.54*** (0.07)	0.52*** (0.06)	0.61*** (0.05)	0.61*** (0.05)
Network Size	0.24*** (0.04)	0.23*** (0.03)	0.07* (0.04)	0.07* (0.04)
Right-Wing	-0.06** (0.03)	-0.07** (0.03)	-0.16*** (0.05)	-0.16*** (0.05)
Labor Share	-1.11*** (0.19)	-1.13*** (0.19)	-1.35*** (0.17)	-1.35*** (0.17)
Connex		0.07 (1.15)		-0.15 (3.02)
Agir		-0.7*** (0.08)		-0.37*** (0.07)
Keolis		0.8*** (0.04)		-0.33*** (0.06)
Error Sd. Dev.	0.11*** (0.004)	0.11*** (0.004)	0.05*** (0.003)	0.05*** (0.003)
Firms Fixed effects	Yes	Yes	Yes	Yes
# of Observations	300	300	93	93

\*\*\* Significant at the 1 percent level,

\*\* Significant at the 5 percent level,

\* Significant at the 10 percent level.

Table 3: Estimated Subsidies II

	$\hat{\underline{b}}$	$\hat{\bar{b}}$
Average (1000 Euros)	13487** (6436)	16490** (7249)
# of Observations	579	579

\*\*\* Significant at the 1 percent level,

\*\* Significant at the 5 percent level,

\* Significant at the 10 percent level.

Table 4: Renegotiation-proof: Inefficiency distribution and social value of effort

Variables	Social value of effort $k$		
	I	II	III
Agir	-0.05 (0.05)	-1.05** (0.41)	1.00*** (0.25)
Keolis	0.06 (0.04)	-0.03 (0.10)	0.29** (0.11)
Transdev	0.45*** (0.10)	0.37* (0.19)	-0.94*** (0.37)
Agir $\times$ size		4.08*** (1.58)	
Keolis $\times$ size		0.46 (0.39)	
Transdev $\times$ size		1.17 (0.78)	
Agir $\times$ Engineers			-3.80*** (0.92)
Keolis $\times$ Engineers			-0.89** (0.39)
Transdev $\times$ Engineers			5.01*** (1.57)
First Period Weight $\beta$	0.39*** (0.06)	0.25*** (0.08)	0.41*** (0.06)
Mean $\theta$ ( $\times 10000$ )	0.15*** (0.03)	0.14*** (0.04)	0.15*** (0.03)
Stand. Dev. $\theta$ ( $\times 10000$ )	0.29*** (0.05)	0.43*** (0.14)	0.25*** (0.04)
# of Observations		579	

\*\*\* Significant at the 1 percent level,

\*\* Significant at the 5 percent level,

\* Significant at the 10 percent level.

Table 5: Renegotiation-proof: Parameters of interest in Proposition 2

$\lambda$	$\alpha \times \text{right wing}$		
	I	II	III
0.3	1.20*** (0.11)	1.22*** (0.10)	1.21*** (0.11)
# of Observations		392	

\*\*\* Significant at the 1 percent level,

\*\* Significant at the 5 percent level,

\* Significant at the 10 percent level.



Table 6: Welfare differentials for the average network

<b>Welfare Items</b>	<b>Total (in Million Euros)</b>
Subsidy	
- Full commitment	33.6
- Renegotiation-proof	27.5
Differential	+6.1
Social cost	
- Renegotiation-proof	35.7
- Full commitment	43.7
Differential	+8.0
Rent operator	
- Renegotiation-proof	71.3
- Full commitment	79.5
Differential	+8.2
Total welfare	
- Renegotiation-proof	50.9
- Full commitment	53.0
Differential	+2.1
# of observations	114