Dynamic Incentives in Concession Contracts

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Abstract

Public entities often grant concession rights to private firms for the provision of public services. The design of these contracts has important implications for cost efficiency. A longer contract will give more incentives to the private firm to cut costs. However, it will reduce the possibility of replacing the firm with a more efficient one.

In this paper, we analyze empirically this type of contracts. We start by constructing a structural model for typical concession contractual arrangements between a principal and an agent. We then show how to identify and estimate this model using data from french public transportation contracts.

After recovering the model primitives, our counterfactual experiments compute welfare under different scenarios: (i) first best; (ii) using a continuous menu of contracts (iii) using relational incentive contracts (Levin 2003).

1 Introduction

Contracting private agents for the provision of public services is a common practice around the world. Examples of sectors where that is frequent are Public Transportation (Roads,

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Railways, Urban Passenger Transport, Ports, Airports), Water and Sanitation or Energy and Power (Power Purchase Agreements, Fuel Supply/Bulk Supply Agreements, Implementation Agreements, Land Lease) [1]

The design of the concession contracts will be crucial to determine the incentives that the private agent will have to make *investments* in order to improve the efficiency of the provision of the service. One such example is the length of the contract. The trade-off for the public entity in that case is clear. A longer concession contract will give the operator more incentives to invest in cost reduction activities (since it will potentially reap the benefits for more years). Shorter contract will allow more often for the possibility of replacing the private operator with a more efficient one.

Our paper studies these questions by formalizing the typical principal-agent relation into a dynamic structural model. The model allows the agent to make both static effort to reduce costs and (uncontractable) structural improvements to the operational costs (or investment). We then show that this model is identified from contract data and how one can estimate its primitives.

The empirical application uses a panel of public transportation concession contracts from cities in France. The contracts can be of two types: cost plus and fixed price. We estimate the model using that data. Our counterfactual experiments compute welfare (total cost reduction) under different scenarios: (i) first best; (ii) using the optimal continuous menu of contracts (iii) using relational incentive contracts (as in Levin 2003).

We find that...

The paper is organized in the following way. After summarizing the relevant literature, we describe the french transportation setting institutional details and the data that we use in the estimation. Following that, we detail the empirical model and the identification and estimation strategies. Finally, we describe the results from our estimation procedure and perform our counterfactual experiments.

[1] http://ppp.worldbank.org/public-private-partnership/agreements/concessions-bots-dbos#examples

2 Literature

THEORY

1. Williamson (1976) Bell Journal
2. Laffont & Tirole (1986) JPE
3. Hart, Shleifer & Vishny (1997) QJE
4. Hart (2003) Economic Journal
5. Iossa & Rey (2014) JEEA

EMPIRICAL

1. Dubois & Vukina (2014) WP
2. Gagnepain & Ivaldi (2002) RAND
3. Gagnepain, Ivaldi & Martimort (2013) AER
4. Joskow (1987) AER
5. Perrigne & Vuong (2011) Econometrica
6. Abito (2013)

3 Institutional Details

This paper studies the incentives to invest in public transport networks, using data from french municipalities. France provides a good setting to study this question. First of all, the country has a large number of relatively homogeneous mid-size cities, each of them with its own transportation network. Second, they are also simillar in terms of their institutional details. Each city has a local authority responsible for organizing the public transport network[2] (henceforth the "regulator"). By law, each of those local authorities has the power to decide how to manage its network. It can either manage it internally or delegate it to a private firm (henceforth the "operator"). In 2011, 91% of cities chose the latter (OECD 2013)

The law n.93-122, from 29 January 1993 (also known as the Sapin Law) regulates the allocating the operation of transportation services to a private party. Every couple of years[3], municipalities are required to launch a new competitive bidding process in which every interested operator can participate. After a first round evaluation of the applications and selection of the subset of firms that qualify, the *regulator* provides further information on the type of service required. After that, *operators* submit their final bids and reports. Finally, the regulator selects a small group of firms, enters into further negotiations of the terms with them and makes the final selection.

The final agreement will establish the duration of the contract, service requirements (network structure, number of lines, frequence of service, so on), passenger fares and the general remuneration of the *operator*. Procurement contracts can be classified into three types, according to which party takes the risks of the project:

- **Net Cost Contracts:** the operator receives a fixed subsidy and it is responsible for collecting ticket revenues from users. Therefore, the operator will face both cost and demand risks.
- **Gross Cost Contracts:** the operator receives a fixed subsidy but the collection of money from ticket sales remains on the side of the regulator. In other words, the only uncertainty that the operator has is in terms of operating costs.
- **Management Contracts:** the regulator pays the costs of the operator and gives him a small fixed subsidy on top of that. All the risks stay with the regulator.

[2] *Les autorits organisatrices du transport urbain (AOTU)*

[3] Contracts are for a fixed duration, usually 5 or 6 years (World Bank 2000)

The first two types of agreements are commonly referred in the literature as *Fixed Price (FP)* contracts. The third type is usually classified as a *Cost Plus (CP)* contract.

We will now focus our attention in two characteristics of the industry which will be important for our modelling approach: cost reduction effort activities and specificity of the investment made by operators.

Cost Reduction Effort

Despite the fact that most characteristics of service (like number of stops, frequency, so on) are fixed in the contract, there are still many ways in which the operator can affect the costs of running the network. We find it convenient to classify the cost reduction effort into two types: those activities that have an effect only in the current period (*static effort*) and those that reduce the cost structure and, therefore, will have an impact during a large number of periods in the future (*dynamic effort*).

The static effort activities are those that are more frequently discussed in the literature (Laffont & Tirole 1986). One such example is the monitoring of drivers by firm managers (Gagnepain & Ivaldi (2002)). It is costly for the firm but it can optimize fuel consumption or reduce the number of traffic accidents/disputes.

However, most of the cost reducing activities will have a long term (structural) effect. Examples of that are (i) improved training of drivers[4] (ii) maintenance of buses [5] and (iii) realization of studies to optimize the network[6] .[7]

[4] *"...high performance levels (...) owe much to the training programme followed by the drivers, who in 2012 were the first to use Keolis driving simulators. These replicate a broad range of scenarios, putting trainees in real-time situations so that they can practice performing the correct actions and applying the right procedures in a virtual environment".* from Keolis Group Worldwide 2012

[5] *"Conducted in partnership with employees, the KeoLean approach aims to improve working conditions and maintenance efficiency through process optimisation. The method has already yielded tangible results in several countries. In Belgium for example, these include reducing the time spent on the maintenance of Sprinter vehicles from 160 to 60 minutes, and cutting the distance travelled by mechanics from 1,152 to 643 metres.* from Keolis Group Worldwide 2012

[6] There is plenty of evidence that the operators know better than the regulator how to optimize the network in terms of costs, particularly in small cities (CERTU 2003). For this reason, the former often suggests improvements that the latter tend to accept.

[7] It can be the case that some details of the dynamic effort activities, like total amount of Euros to be

Other type of investment (in physical capital) to increase the rolling-stock or the size of the network is typically undertaken by the municipality directly and, therefore, not relevant for this paper.

Specificity of the Investment

An interesting characteristic of our setting is that all the cost reduction actions that have long term impact will be specific to a particular relation between a municipality and an operator. In other words, if the contract is terminated, the operator will lose any amount *invested* in order to reduce costs.

The reasons for this are listed below:

- By law (article L.122 -12 of the Labour Code), the drivers work for the municipality and have to be re-hired by the new operator. Hence, any investment in training is lost;
- The rolling stock (buses and so on) are propriety of the city. Any maintenance that the operator makes will benefit any new operator;
- Any effort to reduce costs by optimizing service is evidently lost as well and any gain will transfer to the city (and any future operator).

4 Data

The data used for this study comes primarily from a survey of firms and regulators implemented by CERTU, a public research center specialized in infrastructure and transportation. The survey is implemented on a yearly basis and collects information about the output, costs, technical characteristics and some regulatory aspects of the networks and operators for the period 1995 to 2012. The surveys are not mandatory, therefore, there is some degree of non-response specially for small firms and regulators and for the earlier years of the sample.

spent on maintenance, are established in the contract. However, the regulator will not be able to guarantee (without the proper incentives) that the operator will make its best effort to spend the money appropriately.

Using the survey we have information about operating costs, commercial revenues and rates, contract details (type of contract, starting/ending dates), regulator's and firm's characteristics (legal regime, corporate attachment in the case of the operators), input usage (fuel, labor, number of vehicles), output (kilometers travelled, capacity provided, number of passengers), network characteristics (population and area of the network, number of lines, total length of the lines, number of stops, frequency and speed of service), etcetera. We complement this with information about the results of the municipal elections that took place during the sample period from the Ministry of Interior, and the average wages, gasoline prices and the consumer price index from the French National Institute of Statistics and Economic Studies (Insee).

Descriptive Statistics

Table XXX shows summary statistics by contract type, taking each city-year as the unit of observation and pooling all the sample years. The figures show that city-years under FP regulation have in average higher operating costs, lower output (measured by the seat-kilometers supplied by the network operator) and higher average costs.[8] Furthermore, the populations and network areas do not differ greatly between contract types, but input usage (labor and fuel) does, which could suggest productivity differentials. The difference in average costs is further illustrated in Figure XXX which depicts the non parametrically estimated distribution of average costs by contract type. The distribution associated with FP contracts exhibits a higher mean and dispersion compared to the distribution with CP contracts.

The observed differences are not necessarily due to performance differentials induced by the contracts, but could also be the result of the regulators' contract selection decisions. For example, regulators of cities with current bad performance could favor a switch to an FP contract. Higher-powered contracts, like the net and gross cost contracts that we categorize

[8]Operating costs divided by the seat-kilometers supplied.

as FP, can provide incentives for cost reduction investments if the contract terms are fixed for a number of periods. Additionally, these investments can take some time to bear fruit, in terms of observable cost reductions. All in all, the observed higher cost for FP can be the result of both mechanisms, which seems consistent with the history of the industry, and is suggested by the data. First, FP contracts are statistically longer in average than CP contracts, as we can see in Table XXX. Second, FP contracts become increasingly prevalent in the sample, going from around 68.6% of networks by 1995, to 91.1 % in 2012, reflecting an increasing and explicit concern for cost control by the regulators.

In order to assess more precisely the investments in cost reduction under FP contracts, controlling for the unobserved specific investments accumulated by the firms, consider the sample of firms that just switched from CP to FP contracts. Given that CP contracts only compensate for observed operating costs and investments, the incentives for non-observable investments are non-existent under this contractual form. Therefore, comparing the evolution of costs before and after the contractual change should reveal the unobserved investment levels. We implement this comparison by regressing the logarithm of average costs on a set of variables indicating the time under the new contract, and an interaction of these with an FP dummy, as shown in Table XXX. The time under the new contract should capture the evolution of costs under CP contracts, while the interaction would show the differential evolution for FP firms, that is, the unobserved investments made under these contracts. More specifically, the first three columns of Table XXX use a trend indicating the time under the new contract (`yrs_since_start`, `yrs_since_startXfp`), while the last two columns use time dummies instead (`d_1yr,d_2yr,d_3yr,d_1yrXfp,d_2yrXfp,d_3yrXfp`) to allow for possible non-linearities.[9]

The positive sign of the years under the new contract (although only statistically significant on the first and third columns) show an increase of costs for CP contracts. For FP firms,

[9]All specifications include year-specific dummies and operator fixed effects, except for the first column. In this case, we introduce some time-fixed controls instead of operator fixed effects, as an attempt to control for the unobserved heterogeneity. The results are not that different to the second and third columns.

although the estimates are negative, they are not statistically significant, primarily due to the big standard errors. Allowing for nonlinear effects, using time dummies instead of trends, we find that costs under FP contracts do seem to decrease after starting new contracts (the first two years are not statistically different from zero, but the third year has an statistically significant negative coefficient). In order to increase our sample size and decrease the sizeable standard errors, we also replicate these regressions on the full sample (not only the firms switching contracts). These results are shown on Table XXX. The results in the first three columns are similar to those of the smaller sample, but now statistically significant. For the last two columns, although the time under new contract dummies interacted with the FP dummy are now positive, we still see that they are decreasing according to the year of the new contract.

Reduced Form analysis

- For FP new operators, operational cost decreases with years since start of contract;
- For CP new operators, that effect is not there.
- Same happens for all new contracts, although magnitude smaller?
- FP contracts have significantly longer duration than CP contracts

5 Model

Model Overview

Operator and Regulator. Contractibility, Commitment issues. Observability of θ once in contract, but not ex-ante. Assume regulator has all Bargaining power.

Operator

The transportation operator (henceforth "the firm") has a contract to serve a city for a number of years, at the end of which the contract may or may not be renewed. Each firm j is characterized by a cost type θ_j, with lower values of θ_j corresponding to less efficient types. The fares charged to the transportation users are regulated and exogenous to the firm. As we discussed in Section 3, the firm can take various measures to reduce its costs. We will denote the firm's cost reducing efforts as either e^P or e^I depending on whether the effort is static or dynamic in nature. We denote by e^P the level of effort exerted by the firm in reducing its period costs while we denote by e^I the level of effort that is directed at reducing future costs. As we discussed earlier, e^P captures activities such as monitoring of drivers and e^I captures activities such as putting workers through training programs, re-organizing the structure of the company, etc., that affect the firm's future costs. Both types of effort are noncontractible and the firm incurs costs $\Psi^P(e^P)$ and $\Psi^I(e^I)$.

We let the total operational cost depend on the efficiency of the firm, θ_{jt}, static effort, e^P_{jt}, total relationship-specific capital, K_{jt} and a vector of observable city characteristics X_{jt} as

$$C_{jt} = \overline{C} - \exp(\theta_{jt} + \beta X_{jt} + K_{jt} + e^P_{jt}), \tag{1}$$

where the efficiency of the firm evolves over time as

$$\theta_{jt} = \theta_j + \varepsilon_{jt}, \tag{2}$$

and the level of K_{jt} is endogenously determined by the firm's dynamic effort level e^I,

$$K_{jt+1} = (1 - \delta)K_{jt} + e^I_{jt} + \kappa.$$

The process for θ_{jt} is given by a firm-specific mean (θ_j) plus an i.i.d. shock (ε_{jt}) drawn from a distribution with mean zero. We assume that both the firm and the regulator knows θ_j, but the realization of ε_{jt} is not known to either parties at the beginning of the period. We opted to abstract from asymmetric information regaring θ_j given that there are extensive reporting duties and frequent interactions between the regulator and the operator. We will allow for information asymmetry regarding θ_j only prior to the start of the contract, i.e., before the operator enters into a contractual relationship with the regulator.

We also assume that K_{jt} is observed both to the firm and the regulator. Note that the law of motion for K allows for the possibility that K may grow from passive learning or experience even without any active effort if κ is positive. As we discussed earlier, the accumulated capital stays with the city when the firm is replaced. Therefore, the old operator loses all of the relation-specific capital while the new operator starts out with the capital accumulated by the previous firm.

ASSUMPTION 1. $\theta_{jt} \perp X_{jt}$ in nature (i.e., unconditional on being chosen or having a specific type of contract)

The period t profit of operator j is

$$\pi_{jt} = \tau_{jt}^{FP} 1_{\{FP\}} + \tau_{jt}^{CP} 1_{\{CP\}} - 1_{\{FP\}} C_{jt} - \Psi^P(e^P) - \Psi^I(e^I), \tag{3}$$

where τ^{FP} and τ^{CP} are the transfers from the regulator under fixed price contracts and cost plus contracts, respectively. The transfers are lump sum payments agreed upon at the start of the contract and do not affect the decision of the firm. The third term, C_{jt}, is the operational cost. The operational cost is reimbursed from the regulator to the firm under cost plus contracts. Hence, operational costs are incurred only by firms under fixed price. At the end of the contract period, the regulator decides whether or not to renew the contract. We let the probability of renewal and the distribution of the length of the new contract depend on θ_{jt} and X_{jt}, but not on past and current values of K_{jt}, e^I_{jt}, and e^P_{jt}. This is less of an assumption than a consequence of a more primitive assumption that we impose on the lack of committment power on the part of the regulator.[10]

We can now describe the firm's problem at the t-th year of a T year contract with contract type $c \in \{FP, CP\}$. The value function is expressed as follows:

$$\begin{aligned} V^c(\theta, t, K, X, T) &= \max_{e^P, e^I} \pi + \beta \mathbf{E}[V^c((\theta, t+1, (1-\delta)K + e^I + \kappa, X, T))],\ (t < T) \\ V^c(\theta, T, K, X, T) &= \max_{e^P, e^I} \pi + \beta \Pr(\theta, X) E[V^{c'}((\theta, 1, (1-\delta)K + e^I + \kappa, X, T'))], \end{aligned}$$

where the second line corresponds to the firm's problem in the last year of the contract and the first line corresponds to the firm's problem in all other years. Note that the expectation is taken over the realization of θ' for the first line, and it is taken over θ', c' and T' in the second line. π is the period profit of the operator defined in expression (3) and β is the discount factor.

There are a few things worth mentioning at this point. First, given that θ_j is oberved to the regulator once the firm starts providing services to the regulator, there is no information asymmetry between the regulator and the firm when the contract goes up for renewal. Given that we focus on Markov perfect equilibria as we discuss below, the lack of information asymmetry implies that the regulator always offers a contract that extracts all the surplus from the old operator. Hence, the continuation value for any firm at the last year of contract $(t = T)$ is equal to zero,

$$V^c(\theta, T, K, X, T) = \max_{e^P, e^I} \pi.$$

Second, firms with CP contracts exert zero static and dynamic effort ($e^I_{jt} = e^P_{jt} = 0$) for all t. Firms under CP contracts have no incentive to exert any static and dynamic effort because the regulator cannot commit to provide future surplus to the firm.

For firms operating under FP contracts, the optimal static effort solves

$$\exp(\theta + \beta X + K + e^P) = \Psi^{P\prime}(e^P), \tag{4}$$

[10]Basically, we rule out parties explicitly contracting on K_{jt}, e^I_{jt}, and e^P_{jt}. We also rule out relational contracts.

and the optimal dynamic effort solves the intertemporal Euler equation

$$
\begin{aligned}
(5) \quad \frac{\partial}{\partial e}\Psi^I(e^I) &= \beta \times \mathbf{E}\left[\frac{\partial}{\partial e}\Psi^I(e^{I\prime}) \times (1-\delta) + \exp(\theta' + \beta X' + K' + e^{P\prime})\right] \text{ for } t < T \\
e_I &= 0 \text{ for } t = T.
\end{aligned}
$$

Note that the operator does not have incentives to put in effort for the purpose of influencing the regulator's beliefs regarding its type. This is where the obeservability of θ (to the regulator) matters. If θ were unobservable to the regulator, the regulator has an inference problem and the operator has a signal-jamming incentive as in models of career concerns (Holmstrom, 1993). We opted to abstract from this issue given that there are extensive reporting duties and frequent interactions between the regulator and the operator that mitigate potential informational asymmetry. The only information asymmetry that we consider is when the operator is yet to contract with an operator. That is, once an operator begins providing bus services, the private information of the operator disappears.

Regulator

We now describe the model of the regulator. The regulator must decide, at the end of the contract, whether or not to renew the contract with the current operator or to contract with a new operator. The choice is between the current operator, whose type is known to the regulator, and a new operator whose type is uncertain. The regulator must also decide on the terms of the contract, such as the contract type (fixed price or cost plus), the transfer payments to the firm and the contract duration.

We first describe the search technology for finding potential operators. We assume that the operator takes a draw of θ, which corresponds to the cost type of the potential operator, from some distribution $F_\theta(\cdot; T)$ at the end of the contract period. We let the distribution of the draw to depend on T, the number of years since the previous time the municipality has had an opportunity to change operators. In particular, we assume

$$F_\theta(\theta;T) = 1 - (1 - F_\theta(\theta))^T.$$

Note that $1 - (1 - F_\theta(\cdot))^T$ is the distribution of the minimum of T independent random variables distributed according to $F_\theta(\cdot)$. Hence, our specification allows the municipality to obtain better draws (i.e., smaller draws of θ) as T increases in a natural way. If we were to specify $F_\theta(\cdot;T)$ to not depend on T, this would create artificial (in our view) incentives for the regulator to have short term contracts for the purpose of obtaining many draws.

In order to analyze the contracting problem, we must describe the objective function of the regulator. We specify the objective of the regulator as minimizing the discounted sum of operating costs:

$$-\sum_t^\infty \beta^t(\tau_t^{FP} 1_{\{FP\}} + \tau_t^{CP} 1_{\{CP\}} + 1_{\{CP\}} C_t),$$

where τ_t^{FP} and τ_t^{CP} are the transfer payments under fixed price and cost plus contracts. Specifying the objective of the municipality as cost minimization is quite common (ref?).

At the end of the contract with the current operator, the regulator is faced with a choice of keeping the current operator, whose cost type is known, or contracting with a new operator whose cost type is unknown. For the new firm, the regulator knows only the distribution of the cost type, i.e., $F_\theta(\cdot;T)$. We assume that the regulator first offers a menu of contracts to the new firm. If the new firm finds one of the contracts in the menu acceptible, the regulator replaces the current operator with the new firm. Otherwise, the municipality contracts with the current operator. This particular sequence of events will turn out to be without loss of generality. In the equilibrium we consider, the regulator will offer a contract that extracts all of the firm's surplus if the regulator contracts with the current operator given that the regulator knows the type of the current operator. The regulator's surplus from contracting with the current operator becomes the threat point of the regulator when offering a menu to the potential operator. One implication of this is that the regulator contracts with a new operator if and only if

We now describe the problem of what menu of contracts the regulator should offer to the new operator. In considering this problem, we restrict the contracts in the menu to take the form of either cost plus or fixed price contracts. While optimal contracts under asymmetric information take a fairly complex form, contracts used in practice are typically of very simple form: In our dataset, we observe only cost plus or fixed price contracts and the transfer payments specified in the contracts are not contingent on effort or investment. Note that this still leaves the municipality with a fairly rich set of contracts given that the municipality can offer contracts with different length.[11]

Equilibrium

We now formally define the equilibrium of the game. Let h^t denote the history of actions ($\{e_t^I$, $e_t^P\}$), terms of contract ($\{T_t, \tau_t^c\}$), type of previous firms ($\{\theta_t\}$), observable city characteristics ($\{X_t\}$) and capital ($\{K_t\}$). Then, the regulator's strategy is a rule that specifies, after all history, with whom to contract (current operator or a new operator) and the terms of the contract (contract length, T_t, transfers, τ_t^c, and whether the contract is fixed price or cost plus). The firm's strategy is a mapping from h^t to actions, e_t^I, e_t^P.

Definition (Equilibrium) *An equilibrium is a profile of regulator's strategy and firms' strategies such that the regulator's strategy is optimal given the strategies of the operators and vice versa. A Markov Perfect Equilibrium is an equilibrium in which the regulator's strategy depends just on the current capital, city characteristics and opeator type ($\{K_t$, X_t, $\theta_t\}$), and the operators' strategies depend just on the current capital, city characteristics, operator type, and current contract.*

Note that in a Markov Perfect Equilibrium (MPE), the continuation value of the operators from recontracting must be zero. When the operators are using Markov strategies, the best response of the operator is to extract all of the operator's surplus by lowering the transfer

[11] Cite Rogerson AER

payment. This is possible because at the time of contract renewal, the type of the current operator is fully revealed to the regulator. When the continuation value of the operators is zero, the operators' strategies take a very simple form. Operators under cost plus contracts set $e_t^P = e_t^I = 0$ and operators under fixed price contracts set e_t^P and e_t^I according to (4) and (5).

The regulator's problem of what menu of contracts to offer is a mechanism design problem with the space of contracts restricted to cost plus and fixed price contracts. The regulator's strategy also takes a simple form under MPE. First, the regulator does not offer cost plus contracts that are longer than the minimum required length. Under cost plus contracts, the operator does not invest regardless of the length of the contract. Hence, long cost plus contracts are dominated by shorter cost plus contracts.[12] Second, the MPE will have the feature that all types above a certain threshold opt for a cost plus contract and all types below the threshold opt for a fixed price contract. This is because the operator's utility difference between a fixed price contract and a cost plus contract is always decreasing in the operator's type. Third, the regulaor will offer contracts so that potential operators who are more efficient than the current operator will accept and potential operators who are less efficient than the current operator will not accept.

6 Identification

In the previous two sections we described the data that we have available as well as the empirical model that we estimate in this paper. We now show how the variation in the data is used to identify the primitives of that model.

As detailed before in the data section, we observe, for each period and city, the contract

[12]Suppose that the regulator offers a cost plus contract that is longer than the minimum required length. Consider a shorter contract that makes all types indifferent between the long CP and the short CP. Such CP contracts exist given that the utility difference between any two CP contracts is independent of the type. The regulator strictly prefers the shorter contract because it gives the regulator the opportunity to replace the operator sooner. Note also that having multiple CP contracts does not help for relaxing IC contstraints. This is because all CP contracts that are chosen with positive mass must give the same utility to the operator. Hence, removing one of the CP contracts do not affect the IC for the fixed price contracts.

type (ϕ), its length, the identity of the operator, the operational cost (C_t) and a vector of city characteristics (X_t). The primitives of interest that we want to recover are: the effort cost functions ($\Psi^P(e^P)$, $\Psi^I(e^I)$), the distribution from where the regulator takes draws every period (F_θ), the depreciation rate (δ) and the coefficients on the city characteristics (β).

We will proceed in three sequential steps.

City characteristics coefficients (β) We first restrict our attention to firms under CP contracts in cities that never had any FP type contract. Those will have no incentives to provide effort of any type (i.e. $K_jt = e^P_jt = 0$) and, therefore, the operational cost will reduce to:

$$C^{CP}_{jt} = exp(\theta_{jt} + \beta X_{jt}) \tag{6}$$

In order to recover β from such operators, we need to find a way to fix the type θ while varying X. Our problem is that we do not observe θ directly in the data. However, we can still fix the type. To see this, let's pick all the operators in cities with a particular vector of city characteristics, say X. We know the ranking of operational costs, which gives us the quantiles of θ within that group. We can repeat that for a different set of cities, say those with X', and obtain the quantiles of efficiencies for that group as well. Assumption 1 in the model says that $\theta_{jt} \perp X_{jt}$ in nature. However, as we are conditioning on a particular set of contracts (CP), the orthogonality condition will not hold. That is because we allow for the type of contract to be an endogenous decision and, in particular, to depend on X. The last step of the argument needs to address this issue, which we do by combining assumption 1 with the threshold property of the contract decision[13]. That will give us the following relation between the type quantiles:

$$\alpha' = \frac{\Pr(CP|X)}{\Pr(CP|X')}\alpha \tag{7}$$

[13]If, in a given city, θ receives a FP contract, any $\theta' < \theta$ will receive FP as well, a result of the IC constraints from the regulator problem

where α is a given quantile of the operator types in cities with characteristics X and α' is the quantile of cities with X' that corresponds to the same efficiency level. Since $\Pr(CP|X)$ and $\Pr(CP|X')$, the probabilities of a given contract type are directly observed in the data, we can identify α' for each α. For each such pair, the only difference in operational costs has to come from the city effects, hence identifying the vector β.

Cost of static effort (Ψ_P) and distribution of types (F_θ) In order to identify the effort cost functions, we need to look at the operators that implement a positive amount of effort, those with a FP contract. Furthermore, it helps if we look at those cities in their first year of a FP contract as those will have $K_{jt} = 0$. Therefore:

$$C_{jt}^{FP,yr1} = \exp(\theta_{jt} + \beta X_{jt} - e_{jt}^P) \tag{8}$$

From the first order condition of the static problem (equation 4) and the convexity of Ψ_P, it has to be the case that e^P increases monotonically with θ_{jt}. That means that, for a fixed X, we can learn the ranking of types from the ranking of operational costs.

Now, let's choose any two operators with the same C but in city with different characteristics, say X_1 and X_2. Rearranging the first order confition of the static problem, we obtain the following:

$$C = \Psi^{P\prime}(e^P)$$
$$(\Psi^{P\prime})^{-1}(C) = e^P$$

which means that $e_1^P = e_2^P$. That, in turn, implies:

$$C_1 = C_2$$
$$\theta_1 + \beta X_1 = \theta_2 + \beta X_2$$
$$\theta_1 - \theta_2 = \beta(X_2 - X_1)$$

Note that the right-hand side of the last equation is completely known at this point. Using the same trick that we used before to identify β, we can learn the quantiles (α) of both θ_1 and θ_2 in the distribution F_θ. But now, we also know the actual value of the difference between any two θs. Formally, that means that we learned the following:

$$F_\theta(\alpha_1) - F_\theta(\alpha_2) = \beta(X_2 - X_1)$$

Hence, we have identified F_θ (up to a location normalization).

The next step is to pick two operators with the same X but in different efficiency quantiles: α and α'. Then we can recover the difference in e^P levels between any two operators:

$$ln(C) - ln(C') = (\theta + \beta X - e^P) - (\theta' + \beta X - e^{P\prime})$$
$$ln(C) - ln(C') + (\theta' - \theta) = e^{P\prime} - e^P$$

For each different level of effort, we obtain $\Psi^{P\prime}$. By integrating that expression, we finally recover the object of interest Ψ^P, up to a constant term.

Cost of structural effort (Ψ^I) and depreciation rate (δ) The third step is to show how the variation in the data identifies the primitives guiding the dynamic decisions of the operator. We will do that using necessary conditions for the optimality of the dynamic decision and, thus, eliminating the need to solve explicitly the entire problem.

Consider the optimal choice of e^I. If the firm increases e^I by Δ in the current period, it incurs extra costs equal to

$$\frac{\partial}{\partial e}\Psi^I(e^I) \times \Delta.$$

This will increase tomorrow's capital by Δ. Consider what happens if tomorrow the firm reduces e^I by $\Delta - \delta\Delta$. The firm then ends up with the same capital at the beginning of +2 periods. In the mean time, at period $t+1$, the firm's benefit is going to be

$$\frac{\partial}{\partial e}\Psi^I(e^{I\prime}) \times (\Delta - \delta\Delta) + \exp(\theta_j + \beta X_{jt} - K_{jt+1} - e^P) \times \Delta.$$

Given that, if the first expression is higher (lower) than the second, the firm should decrease (increase) its initial e^I, we should have that (at the optimal choice)

$$\frac{\partial}{\partial e}\Psi^I(e^I) = \underbrace{0.95}_{\text{discount}} \times \left\{\frac{\partial}{\partial e}\Psi^I(e^{I\prime}) \times (1-\delta) + \exp(\theta_j + \beta X_{jt} - K_{jt+1} - e^P)\right\},$$

which is the intertemporal Euler equation.

We can follow in our data most operators since they were CP and through the first years of FP contracts. For those, we can trace the capital sequence (Note that θ, X, $e(\theta, X)$ are all identified, and so the residual is capital accumulation [14])

From the law of motion of capital, we would be able to link each sequence of $\{K_{jt}\}$ to the corresponding sequence of $\{e^I_{jt}\}$ as long as we knew the discount factor δ. One possible way to learn the value of δ is by looking at firms that suddenly change from a FP to a CP contract. Those are cases where there was some capital accumulated in the past but where $e^I = 0$. Therefore, any change in capital from one year to the enxt has to come from depreciation. [15]

Hence we have the sequence of $\{e^I_{jt}\}$ for each firm. Any two consecutive points in the sequence will allow us to use the intertemporal Euler equation detailed above to place one restriction on the shape of $\Psi^{I\prime}()$. With a sufficient number of such restrictions, we can recover that function in an (almost) non-parametric way.

[14] In fact, what we observe is the sequence of capital with noise (the stochastic shock on θ - ϵ). However, since ϵ is mean zero, we can trivially take the expected value over a set of operators and the noise will disappear

[15] An alternative approach would be to allow some constant learning k for all operators and identify depreciation from changes in capital from operators with a CP contract

7 Estimation

The proposed estimation procedure follows the identification of the model presented in the previous section.

Estimation of β

Conditioning on having currently, and in every period in the past, a CP contract we can actually condition on firms that have neither accumulated any relationship-specific capital nor exert any static effort. Controlling for these unobservables makes the estimation of the effects of the observables straightforward. If ϕ_{jt} is the contract type at time t for firm j, and $\phi_j^t = (\phi_{j1}, \phi_{j2}, ..., \phi_{jt})$ is its contract history up to time t, then:

$$E\left[\log C_{jt} | X_{jt}, \theta_{jt}, \phi_j^t\right] = \beta X_{jt} + \theta_{jt}$$

for any city such that $\phi_j^t = (CP, ..., CP)$. Conditioning only on observables, for the same history as the previous equation, this implies:

$$E\left[\log C_{jt} | X_{jt}, \phi_j^t\right] = \beta X_{jt} + E[\theta_{jt} | X_{jt}, \phi_j^t]$$

Given that the regulator uses a threshold rule to select contracts, it is clear that the mean of the unobserved productivity is not independent of the contract history. Allowing the threshold to depend on city characteristics that also affect costs, would also mean that this mean is not necessarily independent on these cost covariates. However, given that the influence of these variables comes through the threshold rule, this also means that conditioning on the threshold we can control for these influences. We therefore estimate the following equation for cities that are currently, and have always been in the past, under CP contracts:

$$\log C_{jt} = \beta X_{jt} + f(P_{jt}) + \epsilon_{jt} \tag{9}$$

where ϵ_{jt} is an error mean-independent of the other variables in the equation. Here $P_{jt} \equiv \Pr(\phi_{jt} = CP|X_{jt}, \phi_j^{t-1})$, with $\phi_j^{t-1} = (CP, ..., CP)$, is the probability of being under a CP contract at time t given that the city has been under a CP contract until the previous year. Therefore, to estimate the influence of the observable cost covariates on realized costs we propose a simple two stage procedure:

1. Estimate the probability of being under a CP contract for cities that were under a CP contract until $t-1$, using X_{jt} as explanatory variables. We use a Probit model for this. To increase the flexibility of this model, we interact the explanatory variables in the linear index. Obtain the predicted probabilities $\hat{p}_{jt}$.
2. Estimate equation (9) using a polinomial of $\hat{p}_{jt}$ to flexibly approximate $f(.)$.

Estimation of $F_\theta(.)$ and $\Psi(.)$

To estimate the cost of static effort function without dealing with the effects of dynamic effort, we move on to the sample of cities that are under their first year of FP contract. These cities have incentives to exert some level of static effort but have not accumulated relationship-specific capital at this point. The estimation strategy is to fit a flexible parametric distribution function to the distribution of productivities implied by the realized costs. We also use information on the implied productivities for cities that were under CP regulation in every period. Although the latter do not provide information to estimate $\Psi(.)$, they improve the estimation of the parameters of $F_\theta(.)$.

The procedure is as follows:

1. For cities in their first year of FP contract, and given some cost of static effort function, $\Psi(.)$, calculate the static effort implied by the first order condition:

$$C_{jt} = \Psi'(e_{jt}^P) \tag{10}$$

We use a quadratic function for $\Psi(.)$ and gather its parameters in the vector ξ_P. To clarify the dependence on this vector, we denote the backed-up static efforts as $e^P_{jt}(\xi_P)$.

2. Using equation XXX we then backup the unobserved productivity for each firm. In the case of firms under FP contracts, these are obtained:

$$\hat{\theta}_{jt} = \log C_{jt} - \hat{\beta} X_{jt} + e^P_{jt}(\xi_P) \tag{11}$$

while for the cities under CP regulation the equation used is:

$$\hat{\theta}_{jt} = \log C_{jt} - \hat{\beta} X_{jt} \tag{12}$$

where $\hat{\beta}$ are the parameters estimated in the previous stage.

3. Finally, we match the empirical moments of the implied productivities with their theoretical counterparts. The latter are obtained from an assumed parametric distribution, from which we derive: (i) the mean of the unobserved productivities conditional on having an FP contract for the first time at time t, (ii) the mean of the unobserved productivities conditional on having always had a CP contract.

In particular, we consider the following moment condition

$$\Theta \equiv E\left[\left(\theta_{jt} - E[\theta_{jt}|\phi^t_j;\xi_F]\right).X_{kjt}\right] = 0, \qquad \text{for } k = 1, ..., K \tag{13}$$

where the vector ξ_F contains the parameters of the distribution F_θ - because we assume a skew normal shape for the latter, it is a three-element parameter vector (location, scale and shape). Also, for the cities under an FP contract for the first time we have $\phi^t_j = (CP, CP, ..., FP)$, and for the others, $\phi^t_j = (CP, CP, ..., CP)$. Finally, $E[\theta_{jt}|\phi^t_j;\xi_F]$ is the mean of a skew normal distribution conditional on the respective contract histories mentioned previously and given a value of the location, scale and shape parameters (ξ_F). To calculate this we can use the thresholds estimated in the stage 1, that is, the estimated probabilities $\hat{P}_{jt}$. Then, to calculate the mean for cities under CP contracts, for example, we calculate the mean of the skew normal distribution truncated below at the estimate threshold. A similar procedure is followed for the cities under FP regulation for the first time.

Based on the above moment condition, we propose a GMM estimator that minimizes the following objective function:

$$\min_{\xi_1} \quad \hat{\Theta}(\xi_1)'\mathbf{W}\hat{\Theta}(\xi_1) \tag{14}$$

where $\xi_1 = (\xi_P, \xi_F)$, $\hat{\Theta}(\xi)$ uses the implied productivities from step 2, and $\mathbf{W}$ is a moment-weighting matrix. The parameters of $\Psi(.)$ and $F_\theta(.)$ that minimize this distance become our estimated parameters.

Estimation of $\Psi^I(.)$

Now take the sample of cities under FP regulation. Define the gross productivity as $K_{jt}-\theta_{jt}$, and the accumulated productivity as the difference between the gross productivities between time t and 0, so that:

$$\tilde{K}_{jt} \equiv (K_{jt} - \theta_{jt}) + \theta_{j0} = K_{jt} - \sum_{k=0}^{t} \varepsilon_{j,t-k}$$

Using the equation for K_{jt} one can show that:

$$e^I_{jt} = \tilde{K}_{jt+1} - (1-\delta)\tilde{K}_{jt} + \tilde{\varepsilon}_{jt+1}$$

where

$$\tilde{\varepsilon}_{jt+1} = \sum_{k=0}^{t+1} \varepsilon_{j,t+1-k} - (1-\delta)\sum_{k=0}^{t} \varepsilon_{j,t-k}$$

That it, having estimates of K and θ we can recover e^I_{jt} with error. Let us denote $e^I_{jt} - \tilde{\varepsilon}_{jt+1}$ by $\tilde{e}^I_{jt}$, and recall that:

$$\mathbf{E}\left[\frac{\partial}{\partial e}\Psi^I(e^I_{jt})\middle| X_t\right] = 0.95 \times \mathbf{E}\left[\frac{\partial}{\partial e}\Psi^I(e^I_{jt+1}) \times (1-\delta) + C_{jt}\middle| X_t\right].$$

Assuming that $\frac{\partial}{\partial e}\Psi^I(\cdot)$ is linear, this implies:

$$\mathbf{E}\left[\frac{\partial}{\partial e}\Psi^I(\tilde{e}^I_{jt})\middle| X_t\right] = 0.95 \times \mathbf{E}\left[\frac{\partial}{\partial e}\Psi^I(\tilde{e}^I_{jt+1}) \times (1-\delta) + C_{jt}\middle| X_t\right]$$

So we use this equation to form a moment condition. The estimation procedure is as follows:

1. Estimate the gross productivities using the equation:

$$K_{jt} - \theta_{jt} = -(C_{jt} - X_{jt}\beta + e^P_{jt})$$

   where the static effort is implied from the first order condition $\Psi'(e^P_{jt}) = C_{jt}$, and where we use the previously estimated values for β and ξ_P (the parameters of the function Ψ). Estimate $\tilde{K}_{jt}$ by adding the estimated θ_{j0} (this is obtained from the previous equation, applied to $t = 0$).

2. Estimate $\tilde{e}^I_{jt} \equiv e^I_{jt} - \tilde{\varepsilon}_{jt+1}$ using the equation:

$$e^I_{jt} - \tilde{\varepsilon}_{jt+1} = \tilde{K}_{jt+1} - (1-\delta)\tilde{K}_{jt}$$

   for a given value of the depreciation rate, δ. To keep track of this dependency, denote $\tilde{e}^I_{jt}(\delta)$.

3. Consider the moment condition based on the previous discussion:

$$\Xi \equiv \mathbf{E}\left[\left(\frac{\partial}{\partial e}\Psi^I(\tilde{e}^I_{jt}) - 0.95(1-\delta)\frac{\partial}{\partial e}\Psi^I(\tilde{e}^I_{jt+1}) - 0.95C_{jt}\right).X_{kjt}\right] = 0$$

We can use this moment condition to estimate the vector of parameters $\xi_2 = (\delta, \xi_I)$, where ξ_I is a vector containing the parameters of $\Psi^I(.)$. In order to do this, compute an estimate of Ξ conditional on some particular values of the parameter vector ξ_2, $\hat{\Xi}(\xi_2)$. The GMM estimator would be the vector of parameters that minimizes:

$$\min_{\xi_2} \quad \hat{\Xi}(\xi_2)'\mathbf{W}\hat{\Xi}(\xi_2) \tag{15}$$

where $\mathbf{W}$ is an appropriate moment-weighting matrix.

8 Results

[to be written]

9 Counterfactual

Using the structural estimates that we have obtained, we will now simulate the capital path under three different alternatives: (i) first best (the operator makes decicions to maximize the common good); (ii) using relational incentive contracts (as in Levin 2002,2003); (iii) using a continuous menu of contract types (as in Laffont-Tirole 1986).

I - First Best

Idea: Compute the sequence of capital chosen by a benevolent planner (the efficient) and compare the sum of discounted costs of operating the network with the path chosen by agents that maximize its profits (the optimal).

Need to solve the dynamic problem:

Operator Problem (Optimality)

The value function of operator of type θ with K of capital accumulated, in a city with X characteristics and having t years left of contract will be given by the following expression

(A) If $t > 0$:

$$\begin{aligned} V(\theta, K, X, t) &= \max_{\{e^P, e^I\}} -C(\theta, K, X, e_P) - \Psi^P(e^P) - \Psi^I(e^I) \\ &\quad + \underbrace{0.95}_{\text{discount}} \int_t^\infty V(\theta, \delta K + e^I, X', t-1) dF_X \end{aligned}$$

(B) If $t = 0$:

$$\begin{aligned} V(\theta, K, X, t) &= \max_{\{e^P, e^I\}} -C(\theta, K, X, e_P) - \Psi^P(e^P) - \Psi^I(e^I) \\ + \Pr(\tilde{\theta} &> \theta) * \underbrace{0.95}_{\text{discount}} \int_t^\infty V(\theta, \delta K + e^I, X', \tau) dF_X dF_\tau \end{aligned}$$

In the last period of a contract (B), there are two differences in the expression. First, the continuation value will only occur if the draw of the new operator is of a worst type ($\Pr(\tilde{\theta} > \theta)$). Second, the duration of the new contract (τ) will be a random variable taken from a distribution F_τ.

Assume for now that we know the object F_τ (more on how to recover that distribution later)

How to solve this problem for a given set of parameters?

1. Check that the Blackwell sufficient conditions for a contraction are met.

$T : B(x) \to B(x)$

(1.1) (*monotonicity*)

(1.2) (*discounting*)

2. Guess $V(x)$, then iterate until convergence to the unique fixed point

3. Obtain the policy function that solves the problem and simulate the path of capital for a fixed representative θ

Planner Problem (Efficiency)

- In order to solve the dynamic problem of the operator, we need to know the distribution contract durations that the agent expects to face if the current contract is renewed (F_τ).

The value function of the problem of a central planner that lets more efficient types replace previous ones but makes them invest the efficient amount (to minimize the sum of discounted costs):

(A) If $t > 0$:

$$V^{EF}(\theta, K, X, t) \equiv V(\theta, K, X, t)$$

(B) If $t = 0$:

$$\begin{aligned}
V^{EF}(\theta, K, X, t) &= \max_{\{e^P, e^I\}} -C(\theta, K, X, e_P) - \Psi^P(e^P) - \Psi^I(e^I) \\
+\Pr(\tilde{\theta} &> \theta) * \underbrace{0.95}_{\text{discount}} \int_t^\infty V^{EF}(\theta, \delta K + e^I, X', \tau) dF_X dF_\tau \\
+\Pr(\tilde{\theta} &< \theta) * \underbrace{0.95}_{\text{discount}} \int_t^\infty V^{EF}(\tilde{\theta}, \delta K + e^I, X', \tau) dF_X dF_\tau dF_\theta
\end{aligned}$$

Regulator Problem

In order to solve the operator problem, we need the distribution of contract durations (F_τ), which arises from the decisions of the regulator. There are two options to recover that object:

(a) Empirical estimation of that distribution (exogenous assumption)

We can simply recover that distribution directly from the data. Set

$$\tau \sim T(\theta, K, X)$$

and estimate the function $T()$.

(b) Solve the problem of the regulator (endogenous contract duration)

1 - Find the solution to the regulator problem (that balances the option value of having a better draw with the incentives to invest).

2 - Call that solution τ^U, or the unconstrained optimum.

$$\tau^U = f(\theta, K, X)$$

3 - Contracts, however, have minimum lenghts for outside reasons (political reasons, cost of negotiation, so on). We get the ditribution of the constraints for the contract durations from the duration of CP contracts. Absent those constraints, the duration for those contracts should be always 1 period. The working assumption is that the constraint is independent from the characteristics of the operator. Let $F_\tau^{\min}$ be the distribution of duration constraints.

4 - Use the distribution $F_\tau^{\min}$ jointly with the solution to the regulator problem τ^U to generate the distribution of contract lengths (restricted) that the operator will face. The solution to that problem will be (check that it is in fact true):

$$\tau^R = \begin{cases} f(\theta, K, X) & if \tau^{\min} > \tau^U \\ \tau^{\min} & if \tau^{\min} < \tau^U \end{cases}$$

Additional Comments:

- In order to solve for the optimal choice of τ for every possible combination of θ and K, use properties of the optimal (monotonicity and so on, simillar to Panle Jia's paper)

- An important trick is that we don't need to solve the optimal lengths of high (low quality) thetas in order to find the optimal of low (high quality) thetas.
- Then, for a fixed solution of the regulator, we start by solving the problem of the operator. Then we iterate back to the problem of the regulator.

II - Continuous menu of contract types

[to be written]

III - Relational incentive contracts

Part of the reason that we have underinvestment in this setting is that there are no explicit mechanisms to write formal contracts contingent on investment/capital. However Levin (2002, 2003) shows that, even in that case, informal agreements contingent on the actions of the agent could arise and be self-enforcing and welfare improving for all parties. In the following exercise, we compute the potential gains from such an arrangement.

In our setting a relational incentive contract differs from a standard incentive contract because it includes a discretionary reward function. We assume that the reward will be received by the agent in the end of the contract and will be a function of all the investment made during that contract, i.e., we can write that function as $b_t = B(i_t, K_{t-1})$

Note that the reward is informal and cannot be enforced by a court of law. The trade-off for the regulator will be the following: if he decide to renegue on the reward promise, he will save that amount but future operators will invest less. On the other hand, if he does pay, future operators will believe that the regulator is "nice" (faithful to its promises) and will invest more. The operator knows that the regulator will only keep its promise if it is in its own interest to do so.

We will look at a trigger-strategy type of relational contract in that the beliefs of the operators will be the following:

$$\text{regulator is} = \begin{cases} \text{"truthful" if always payed the promised bonus} \\ \text{"lier" otherwise} \end{cases}$$

Formally, a *relational* incentive contract will be a tuple $(\phi, \tau^{\phi}, b())$. As in the *standard* incentive contracts, it defines the type ($\phi \in (CP, FP)$) and transfer (τ^{ϕ}). However, it also includes a discretionary bonus function.

In order for the relational contract to be feasible, it has to be able to improve total welfare. That is true if it exists a feasible capital path K^{RC} such that:

$$\sum_{t=0}^{\infty} \beta^t E_{\theta,X}\left[\pi_{jt}(K^{RC})\right] > \sum_{t=0}^{\infty} \beta^t E_{\theta,X}\left[\pi_{jt}(K^{*})\right]$$

where K^* is the capital sequence under simple incentive contracts.

The regulator will solve the following problem (to make notation simple, assume for now that we have a FP contract for a given duration T_0):

$$\min_{\tau,b} \sum_{t}^{\infty} \beta^t(\tau_t + b_t)$$

subject to

$$\text{(IC-reg)} \qquad -\sum_{t}^{\infty} \beta^t(\tau_t^{RC} + b_t) > -\sum_{t}^{T_0} \beta^t(\tau_t^{RC}) + -\sum_{T_0}^{\infty} \beta^t(\tau_t *)$$

$$\text{(IC-op)} \qquad \sum_{t}^{T_0} \beta^t(\tau_t^{RC} + b_t - C^{RC} - \Psi^{P,RC} - \Psi^{I,RC}) > \sum_{t}^{T_0} \beta^t(\tau_t^{*} - C^{*} - \Psi^{P,*} - \Psi^{I,*})$$

10 Tables

Table 1: Summary Statistics by Contract Type

	(1) CP (Full)	(2) FP (Full)	(3) CP (Partial)	(4) FP (Partial)
Operating cost (000's of Euros)	12481.8	14539.0	13961.7	18858.3
	(26712.0)	(35099.6)	(12808.5)	(25152.0)
Seat-kilometers	303932.1	270380.7	363822.3	362115.5
	(587392.6)	(684322.9)	(365329.6)	(458261.4)
Average cost (000's of Euros/seat-km)	0.0379	0.0723	0.0368	0.0606
	(0.0125)	(0.373)	(0.0110)	(0.210)
Duration (years)	6.474	7.268	6.249	7.658
	(3.585)	(3.697)	(3.378)	(4.130)
Network population	118929.8	111210.1	144690.8	156768.7
	(124505.2)	(160761.6)	(95220.1)	(112773.3)
Network area (square kms)	193.2	197.5	212.4	267.8
	(155.3)	(187.1)	(142.4)	(189.6)
Commercial bus speed (kms/hour)	19.02	20.07	18.55	19.65
	(3.752)	(11.79)	(2.498)	(14.74)
Right wing municipality	0.495	0.503	0.450	0.451
	(0.500)	(0.500)	(0.498)	(0.498)
Wages (euros/hour)	11.20	11.02	11.25	11.18
	(0.921)	(0.937)	(0.676)	(0.824)
Labor (employees-year)	171.8	186.1	218.5	238.6
	(238.7)	(453.4)	(208.8)	(275.8)
Fuel (cubic meters)	1010.8	2112.6	1293.3	1287.7
	(1242.1)	(32781.0)	(1191.9)	(1421.1)
Observations	528	2740	363	1296

The partial sample does not include cities with less than 60,000 or more than 600,000 inhabitants.

Table 2: Summary Statistics by Contract Type (No outliers)

	(1) CP (Full)	(2) FP (Full)	(3) CP (Partial)	(4) FP (Partial)
Operating cost (000's of Euros)	13092.3	16160.6	14153.2	19827.7
	(27590.9)	(37391.7)	(12934.3)	(26098.2)
Seat-kilometers	349016.1	343974.5	394162.1	418356.7
	(619357.9)	(758267.2)	(366262.5)	(470115.0)
Average cost (000's of Euros/seat-km)	0.0380	0.0479	0.0368	0.0473
	(0.0125)	(0.0218)	(0.0110)	(0.0198)
Duration (years)	6.324	7.319	6.214	7.696
	(3.282)	(3.793)	(3.411)	(4.298)
Network population	128749.6	127906.5	147444.1	163957.7
	(129966.4)	(177367.8)	(96555.0)	(117611.4)
Network area (square kms)	195.3	209.4	207.9	266.5
	(153.3)	(189.6)	(136.1)	(186.7)
Commercial bus speed (kms/hour)	18.76	19.78	18.57	19.59
	(2.600)	(11.16)	(2.455)	(14.63)
Right wing municipality	0.513	0.475	0.453	0.424
	(0.500)	(0.500)	(0.499)	(0.494)
Wages (euros/hour)	11.23	11.04	11.25	11.21
	(0.934)	(0.882)	(0.687)	(0.835)
Labor (employees-year)	186.1	214.6	225.1	251.5
	(248.5)	(493.3)	(213.1)	(285.6)
Fuel (cubic meters)	1100.1	2170.7	1342.3	1338.5
	(1280.0)	(34658.9)	(1207.5)	(1462.0)
Observations	449	2097	332	1104

The partial sample does not include cities with less than 60,000 or more than 600,000 inhabitants.

Table 3: Contracts by Year

Years	Concession	Net Cost	Gross Cost	Management	Total
1995	2	67	47	51	167
		(40.1)	(28.1)		
1996	2	74	64	56	196
		(37.8)	(32.7)		
1997	2	80	67	52	201
		(39.8)	(33.3)		
1998	2	75	67	38	182
		(41.2)	(36.8)		
1999	3	85	62	40	190
		(44.7)	(32.6)		
2000	4	81	61	40	186
		(43.5)	(32.8)		
2001	7	99	58	32	196
		(50.5)	(29.6)		
2002	6	113	60	26	205
		(55.1)	(29.3)		
2003	7	121	57	26	211
		(57.3)	(27.0)		
2004	12	135	51	31	229
		(59.0)	(22.3)		
2005	12	128	41	24	205
		(62.4)	(20.0)		
2006	11	134	55	28	228
		(58.8)	(24.1)		
2007	11	142	35	21	209
		(67.9)	(16.7)		
2008	12	133	35	22	202
		(65.8)	(17.3)		
2009	11	123	41	15	190
		(64.7)	(21.6)		
2010	12	158	68	22	260
		(60.8)	(26.2)		
Total	116	1748	869	524	3257
	(3.6)	(53.7)	(26.7)	(16.1)	(100.0)

Table 4: Transition Matrix FP Contracts

	0	1
0	428	68
1	32	2475

Table 5: New operators and all cities

	(1) lcost_avg	(2) lcost_avg	(3) lcost_avg	(4) lcost_avg
yrs_since_start	0.14	0.082	0.083	0.064
	(0.11)	(0.12)	(0.12)	(0.12)
yrs_since_startXfp	-0.088	-0.13	-0.13	-0.087
	(0.15)	(0.19)	(0.19)	(0.17)
fp	0.37			
	(0.30)			
pop_ptu				17.3
				(15.5)
surface				-4.93
				(3.97)
speed				354.9
				(256.6)
Constant	-3.31***	-2.88***	-2.42***	-10.5*
	(0.27)	(0.17)	(0.11)	(5.78)
City_FE	NO	YES	NO	NO
Operator_FE	NO	NO	YES	YES
Year_FE	YES	YES	YES	YES
N	134	134	134	123
r2	0.068	0.044	0.032	0.17
r2_a	-0.017	-0.034	-0.047	0.075

Standard errors in parentheses

This regression uses only new operators (that replaced the incumbent)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: all operators and all-sized cities

	(1) lcost_avg	(2) lcost_avg	(3) lcost_avg	(4) lcost_avg
yrs_since_start	0.0073**	0.011***	0.0071**	0.0078***
	(0.0032)	(0.0037)	(0.0032)	(0.0028)
yrs_since_startXfp	-0.0022	-0.012**	-0.011**	-0.012**
	(0.0048)	(0.0057)	(0.0052)	(0.0052)
fp	0.11***	0.034	0.023	0.020
	(0.023)	(0.035)	(0.036)	(0.034)
pop_ptu				0.69*
				(0.39)
surface				0.28**
				(0.12)
speed				0.46
				(0.78)
Constant	-3.51***	-3.43***	-3.40***	-3.53***
	(0.027)	(0.034)	(0.027)	(0.046)
City_FE	NO	YES	NO	NO
Operator_FE	NO	NO	YES	YES
Year_FE	YES	YES	YES	YES
N	2432	2426	2426	2283
r2	0.22	0.32	0.33	0.33
r2_a	0.21	0.32	0.33	0.32

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Duration regressions using all operators and all-sized cities

	(1) duration	(2) duration	(3) duration
fp	1.07***	0.69	0.82**
	(0.18)	(0.44)	(0.41)
Constant	7.16***	7.07***	6.91***
	(0.42)	(0.41)	(0.36)
City_FE	NO	YES	NO
Operator_FE	NO	NO	YES
Year_FE	YES	YES	YES
N	3201	3181	3181
r2	0.029	0.035	0.027
r2_a	0.023	0.029	0.022

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Structural model estimates (Preliminary)

		(1)	(2)
Psi_p	linear	-0.462	-0.749
	quadratic	3.364	3.474
F_theta	location	-0.272	-0.233
	location x trend		-0.003
	scale	0.425	0.395
	scale x trend		-0.006
	alpha	-0.003	-0.004
Psi_i	quadratic	-0.096	-0.097
	linear	2.900	2.900
Delta	Delta	-0.026	-0.026
GMMobj stat		54.933	48.294
GMMobj dynam		7047.403	7046.908

Figure 1

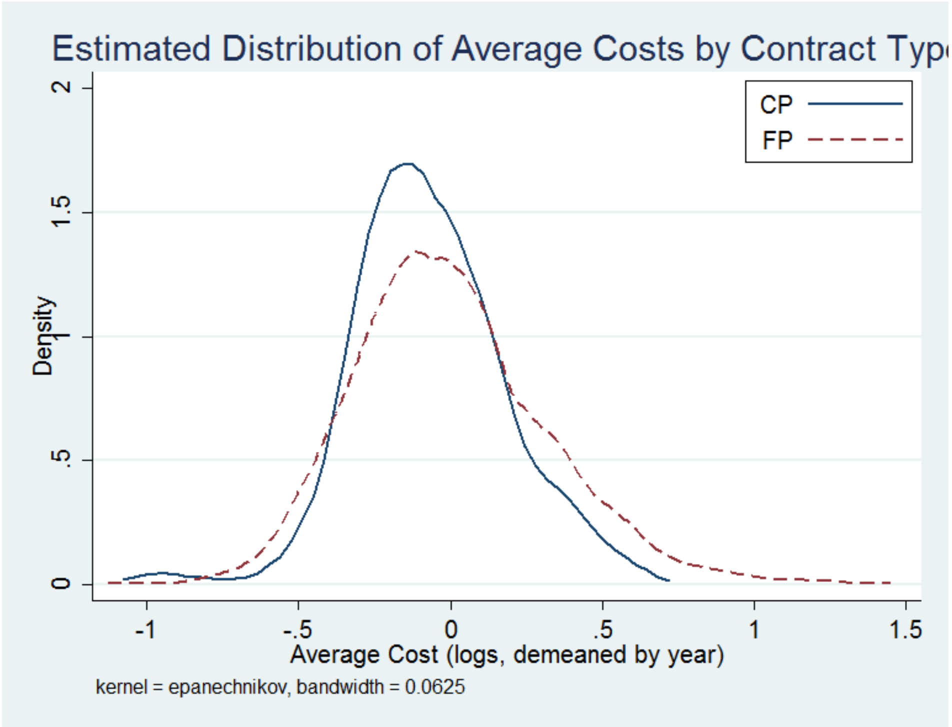


Figure 2

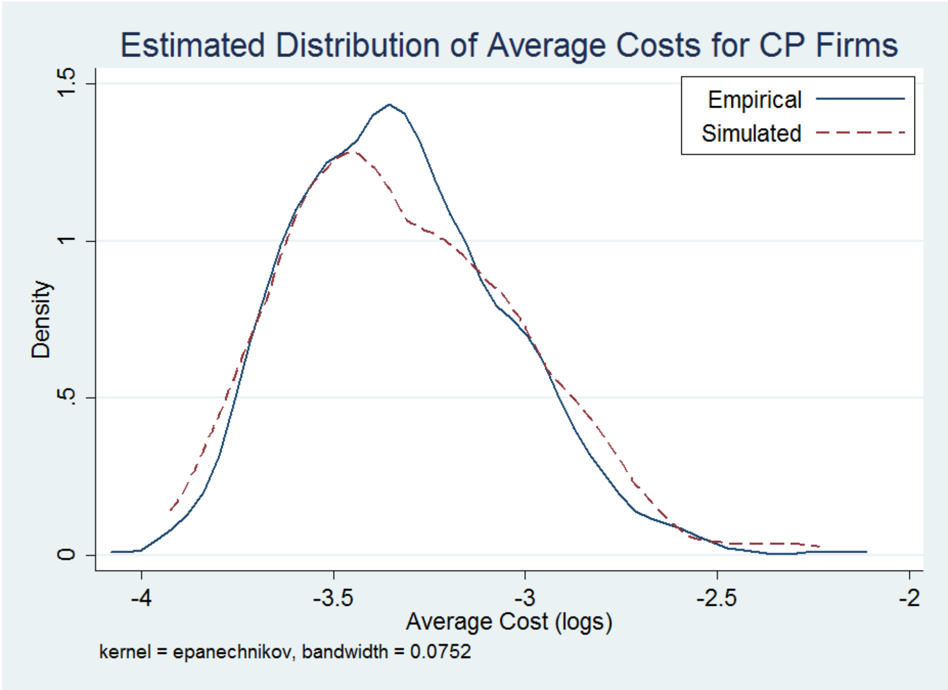
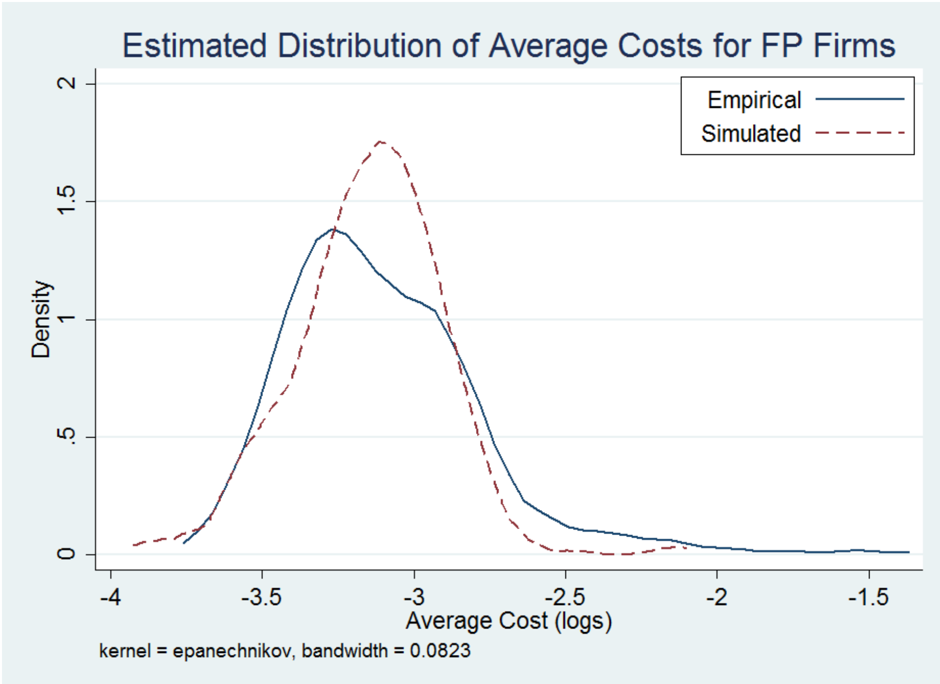


Figure 3


Estimated Distribution of Average Costs for FP Firms
Empirical
Simulated
Density
0
.5
1
1.5
2
-4
-3.5
-3
-2.5
-2
-1.5
Average Cost (logs)
kernel = epanechnikov, bandwidth = 0.0823

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