

Contract choice, incentives, and political capture in public transit [±]

Philippe Gagnepain

Universidad Carlos III de Madrid
CEPR

Marc Ivaldi[§]

Toulouse School of Economics
CEPR

May 2007

Very preliminary version

Abstract: We consider a framework of contractual interactions between urban transport authorities in France and local transport operators. Using a structural model of transport cost and demand that account for these interactions, we shed light on whether changes in the local political majority influence the process of contract choice, or whether current local governments anticipate political changes and strategically distort contracts to influence political outcomes. We also estimate the inefficiency and the cost reducing activity of transport operators. Finally, we simulate the optimal static contract that could be renewed from one contractual period to another if local authorities had the ability to commit not to renegotiate. To conduct the empirical analysis, we use a panel data set that contains information on 50 different urban transport networks over the period 1987-2001. Over the contracting period, one usually observes 3 periods for each urban network, i.e., two renewals of contract that will be the core of the analysis.

[±] The authors wish to thank the Centre d'Etude et de Recherche sur le Transport Urbain (CERTU, Lyon, France) for providing the data. They are grateful to Jordi Jaumandreu, Olivier Armantier, Philippe Marcoul, David Rahman, as well as seminar participants at Iowa State, Loughborough, and the 4th Annual Conference on Railroad Industry Structure, Competition and Investment in Madrid, 2006, for insightful discussions. Gagnepain thanks Ministerio de Educación y Ciencia (SEJ2004-00670), as well as Fundación BBVA for financial assistance.

Departamento de Economía, Universidad Carlos III de Madrid, C./ Madrid, 126, 28903 Getafe (Madrid), Spain; philippe@eco.uc3m.es

[§] Toulouse School of Economics, Université des Sciences Sociales, Place Anatole France, 31042 Toulouse Cedex 9, France; ivaldi@cict.fr

1. Introduction

Industrial economists focusing on aspects of firms' regulation by public authorities have been reconsidering the contractual relationships between regulated utilities and regulators through the window of the theory of incentives and the principal-agent model for more than 20 years. The new theory of regulation probably dates back to the seminal works of Loeb and Magat (1979), Baron and Myerson (1982), and Laffont and Tirole (1986). In such a framework, utilities' productive capabilities and cost reducing effort are two variables that are unknown to the regulator. According to the theory, regulators may submit the utility to the revelation principle in order to extract some information and reduce informational asymmetries. Such so-called second-best optimal solution can be in principle implemented through an optimal menu of linear contracts.

While there is a general consensus on how optimal regulation should be dealt with from a theoretical point of view, the empirical literature seems to be divided between positive and normative analysis. On the one hand, many empirical studies have assumed that the actual regulatory regimes are optimally designed as specified by the new theory of regulation. In a pioneer paper, Wolak (1994) estimates the production function of a regulated Californian water utility. He argues that the regulator actually uses a Baron-Myerson type of mechanism and achieves a second-best welfare level. Wunsch (1994) calibrates menus of linear contracts as proposed by Laffont-Tirole for the regulation of mass transit firms in Europe. Gasmi, Laffont and Sharkey (1997) also consider a regulatory environment a la Laffont-Tirole to estimate operating costs in local exchange telecommunications networks. On the other hand, other studies have explicitly argued that actual regulatory mechanisms do not use such optimal mechanisms. This is the case for instance in Bajari and Tadelis (2001), which focuses on the particular case of the private sector construction industry. They observe that the vast majority of contracts are variants of cost-plus and fixed-price regimes and suggest that the main motivation of the regulator is to find an appropriate trade-off between ex ante incentives and avoiding ex post transaction costs due to costly renegotiation. Their results resonate with themes that are central to transaction cost economics.

This paper proposes an empirical contribution to this on-going debate between positive and normative analysis. It studies the schemes used by the local political authorities in French cities to regulate their urban transport operators. In each city, the urban transport service is regulated by a local authority and is provided by a single operator. These two parties are tied together by a regulatory mechanism that is, in practice, either a fixed-price contract or a cost-plus contract. We assume that the regulator does not observe the technological efficiency or the cost reduction activity of the operator.

Here, we do not assume that actual regulatory mechanisms are optimal in the sense that they do not result from an optimal tradeoff between incentives in operating costs reduction and rents left to the operators. Instead, we assume that the relevant factors that explain the choice of contracts by regulators should be searched on the political side of regulation. A preliminary look at the data suggests that left-wing and right-wing local governments have significant preferences for cost-plus or fixed-price contracts. It is also a common practice in this industry to give rents to workers or firms' shareholders in the form of higher labor charges and/or subsidies, and this may depend again on the political color of the regulator. These observations are in line with Laffont (1996) and Aubert and Laffont (2004). Laffont suggests that considering simultaneously the inefficiency of local political systems and the informational incompleteness of regulators should be relevant. Under incomplete information the political inefficiencies of a majority system may affect the cost reimbursement rules and the incentives of the regulatory schemes: A right-wing regulator may prefer to propose a fixed-price contract to a private firm in order to capture part of its rent. Likewise, a left-wing government is more entitled to give higher wages to the workers of the firm. Aubert-Laffont sheds light on these aspects in a dynamic setting of government capture.

We propose a model of contract choice by local governments that accounts for these political aspects. First, depending on its political color, the regulator chooses the regulatory mechanism that maximizes its utility over two periods of elections. Second, the regulator chooses optimal prices. The optimal characteristics of the contracts and prices are obtained according to some observed or known parameters: Costs, demand elasticities, the local cost of public funds and an engineering relation between demand and capacity. Moreover, the regulatory rule affects the operator's behavior and associated operating costs in one way or another. The econometric task consists in recovering the parameters of a model of supply and demand, testing the relevance of the asymmetric information hypothesis, testing the relevance of the political capture hypothesis, and evaluating the first-best regulatory schemes that can be designed using the estimates. We construct a structural cost equation that obeys to the incentive-pricing dichotomy principle and allows us to discuss the estimation of the supply model and the econometric analysis of the demand model independently.

We extend here the line of research initiated in Gagnepain and Ivaldi (2002). In this initial project, we assumed that the choice of regulation was exogenous and we restricted our attention to the construction of the cost function. We show in the paper that accounting for the choice of contracts turns out to be adequate and fruitful, since it improve the quality of our estimates. With a non-nested test, we show how our new model improves upon the previous one in a significant manner.

The organization of the paper is as follows: Section 2 describes the regulation of urban transportation in France in more details and presents our database. Section 3 discusses the

assumptions that are maintained throughout the paper. Section 4 introduces a theoretical modeling of the main features of urban transportation and the environment in which network operators and regulators make their decisions. Section 5 then presents a formal specification of the cost function and the effect of regulatory constraints. Section 6 is devoted to the discussion of the estimation method and results on the supply side. Dealing with the demand side, section 7 derives the first-best optimal regulatory arrangements and compares them to the actual arrangements in terms of welfare changes. Section 8 provides a summary and some concluding remarks.

2. The French urban transport industry

As in most countries, urban transportation in France is a regulated activity. Local transport networks cover each urban area of significant size; a local authority (a city, a group of cities or a district) regulates each network whereas a single operator provides the service. Regulatory rules prevent the presence of several suppliers of transport services on the same urban network. A distinguishing feature of France compared to most other OECD countries is that about eighty percent of local operators are private and are owned by three large companies, two of them being private while the third one is semi-public.¹²

In 1982, a law on the organization of transport within France was promulgated whose main objectives are to decentralize urban transportation and to provide a guide for regulation. As a result, each local authority organizes its own urban transportation system by setting the route structure, the level of capacity and quality of service, the fare level and structure, the conditions for subsidizing the service, the level of investment and the nature of ownership. It may operate the network directly or it may concede service to an operator. In this case, a formal contract defines the regulatory rules that the operator must support as well as the payment and cost-reimbursement rule between the principal and the agent. In 1995, 62% of systems were operated under fixed-price contracts and 25% were operated under cost-plus contracts. Local authorities owned and directly operated only 6% of the networks. In 2002, these figures had changed significantly since fixed-price contracts were met 75% of the cases, cost-plus regimes in 14% of the cases; by then, local authorities owned 9% of the networks. The remaining % are small urban transport systems, which are not included in the database.

¹ For an overview of the regulation of urban transit systems in the different countries of the European Union, in the United States and Japan, see IDEI (1999).

² These companies, with their respective type of ownership and market share (in terms of number of networks operated) are in 2002: KEOLIS (private, 30%), TRANSDEV (semi-public, 19%), CONNEX (private, 25%). In addition there are a small private groups, AGIR, and a few firms under local government control.

In most urban areas, operating costs are twice as high as commercial revenues on average. Budgets are rarely balanced without subsidies. One reason is that operators face universal service obligations. Prices are maintained at a low level in order to ensure affordable access to all consumers of public transportation. Moreover, special fares are provided to special groups like pensioners and students. The subsidies come from the State budget, the budget of the local authority, and a special tax paid by any local firm (having more than nine workers). They are not necessarily paid to the operator. Under fixed-price contracts, operators receive subsidies to finance the expected operating deficits; under cost-plus regulation, subsidies are paid to local authorities to finance ex-post deficits. In addition to the price distortions causing deficits, informational asymmetries that affect the cost side and lead to inefficiencies make it more difficult to resume these deficits. This is discussed in more details in what follows.

Performing a welfare analysis of regulatory schemes in a one-authority-one-operator setting requires a database that encompasses both the performance and the organization of the French urban transport industry. The basic idea is to consider each system in an urban area during a time period as a realization of a regulatory contract. Such a database has been created in the early 1980s. It assembles the results of an annual survey conducted by the Centre d'Etude et de Recherche du Transport Urbain (CERTU, Lyon) with the support of the Groupement 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 probably unique in France as a tool of comparing regulatory systems to each other and over time. For our study, we have selected all urban areas of more than 100,000 inhabitants for a purpose of homogeneity. However, the sample does not include the largest networks of France, i.e., Paris, Lyon and Marseilles, as they are not covered by the survey. The result is that the panel data set covers fifty different urban transport networks over the period 1987-2001.

3. Delineating the scope of the study

The organization of the urban transportation industry in France motivates the following assumptions.

Assumption 1: The network operator has private information about its technology and its cost reducing effort is unobserved by the authority.

Since French local authorities exercise their new powers on transportation policy since the 1982 law only, and since they usually face serious financial difficulties, they probably have limited auditing capacities. A good audit system needs effort, time and money. French experts on urban

transport blame local authorities for their laxness in assessing operating costs, mainly because of a lack of knowledge of the technology. 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 driver skill), driver behavior toward customers, the effect of traffic congestion on costs, are all issues for which operators have much more data and better understanding than their principals. This suggests the presence of adverse selection. Given the technical complexity of these issues, it should be even harder for the local authority to assess the effort of its agent (operator) to provide appropriate and efficient solutions. It is then straightforward to assume the presence of moral hazard. Informational asymmetries play a crucial role in the setting of contractual arrangements and the design of financial objectives. We turn now to the second assumption.

Assumption 2: Regulatory schemes and operators' efficiency levels are independent.

According to the new theory of regulation, when contractual relationships are characterized by informational asymmetries, a welfare-maximizing regulator applies the revelation principle for providing the operator with incentives to reveal the true efficiency level. This mechanism can be decentralized through a menu of linear contracts and avoids excessive rent leavings. Each operator facing such a menu chooses the contract that corresponds to its own efficiency level. In this context, the most efficient firm chooses the highest-powered incentive scheme, i.e., a fixed price contract while the most inefficient firm chooses the lowest-powered incentive scheme, i.e., a cost-plus contract. Between these two extremes are incentive schemes chosen by firms with intermediate efficiency levels.

Does this framework apply to the French urban transport industry? If it did, fixed-price and cost-plus contracts would be extreme cases of a menu and would be chosen by the most efficient and the most inefficient firms, respectively. Since current rules apply to any companies (even the ones with intermediate efficiency levels) and since the real world cannot be confined to fully efficient or inefficient firms, one must conclude *a priori* that observed contracts do not include any revelation principle, and cost-plus and fixed-price schemes are equally proposed to operators without paying any attention to their efficiency level. In other words, current regulatory schemes are not optimal in this sense.

Documentary investigation of the organization of the urban transport industry and of the regulatory practices suggests that, 30 years ago, the choice of a particular regulatory regime was better explained by historical reasons than as the result of a well-defined economic game. In the seventies, cost-plus contracts were employed in almost 100% of the cases; in the eighties, these contracts represented 60% of the arrangements; in 1995 (2002 resp.), as mentioned before, the cost-plus share goes down to 25% (14% resp). French experts have argued that local

governments were strongly committed to the financing of the public transit system during the seventies, because the notion of universal service was extremely important for them during the period. This is why cost-plus contracts were popular until the beginning of the eighties. Afterwards, due to the uncontrollable increase of operating and investment costs in the whole industry, these local authorities decided to decrease their financial responsibilities and switched to fixed-price contracts. This phenomenon turned out to be more pronounced at the beginning of the eighties (in 1982, when local governments became fully responsible for the public transit system)³ and at the beginning of the nineties (in 1993, when some operating licenses started to be awarded through competitive tendering.)

Therefore, it is realistic to assume that regulatory schemes are not driven by the intrinsic characteristics and efficiency levels of large service companies and of network operators. As already noticed, assumption 2 implies that current regulatory regimes are not optimal; i.e., local governments are not maximizing social welfare. Taking current schemes as given, our objective is now to estimate the main ingredients, i.e., efficiency, cost of public funds, technology, demand characteristics; that are needed to simulate optimal contracts. We show that significant social improvements can be obtained if asymmetries of information are properly taken into account when designing the regulatory contracts.

Assumption 3: Rents are abandoned to workers and shareholders

TO BE WRITTEN

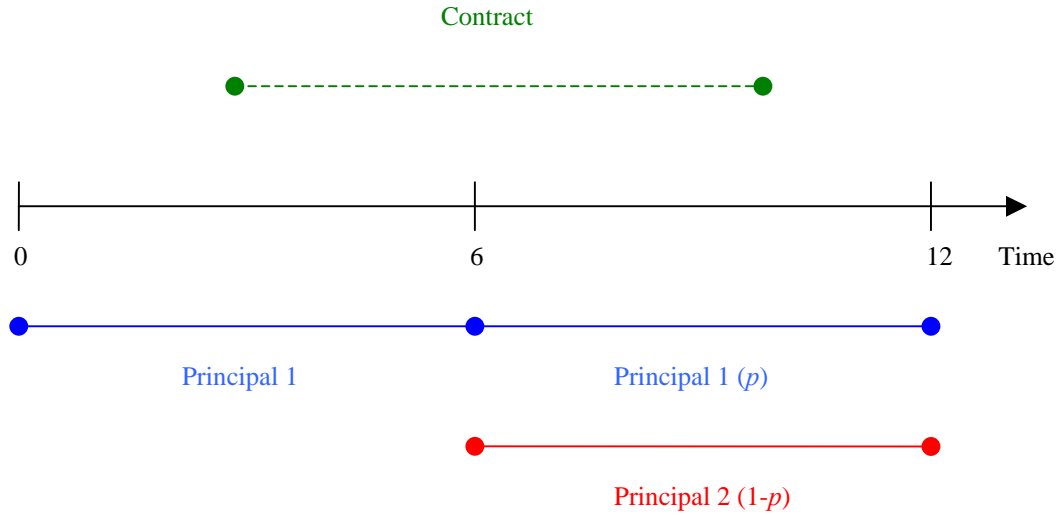
The amounts of subsidy received by the operators are higher than expected in 72% of the cases when the government is right-wing, while 70.4% of the cases when the government is left-wing. Likewise, the size of the labor bill faced by the operators is higher than expected in 32% of the cases when the government is right-wing, while 44% of the cases when the government is left-wing.

4. The economic model

The timing of the contractual relationship between the regulator and the operator is as follows:

Figure 1: The dynamic of contracts

³ The cost-revenue deficit has increased continuously: In 1975, 80% of the operating costs were covered by commercial revenues, 55% in 1992, and only 31% in 2002. Note that local authorities own the rolling stock and the infrastructure and are therefore responsible for the costs due to their renewal.



1. The operator learns its inefficiency parameter θ .
2. The regulator (the current local government) offers a contract to the operator that binds the local government for two periods and commits not to renegotiate it.
3. The operator produces quantity Y_t , exerts the effort level e_t , supports operating costs C_t , and enjoys a profit U_t .
4. At the end of the first period, the current local government remains in power with probability p . It is otherwise replaced by a new one.
5. If the current local government remains in power, quantity Y_{t+1} , effort e_{t+1} , costs C_{t+1} , and profits U_{t+1} occur as specified in the initial contract. If the current government is replaced by a new one, it may renegotiate the initial contract. The operator may or may not accept the new contract. In any case, the new contract necessarily guarantees a profit U_{t+1} that is never lower than the previous profit U_t .

4.1 Program of the operator

The primal cost function

We focus first on the cost side of the model. To produce a volume of service Y_t , firm i requires quantities of labor, l , and materials, m . Denote as w_l and w_m , the price of labor and materials, respectively. Also denote by C the observed operating cost of each firm.

The actual operating cost may differ from the minimum operating cost. Inefficiency may prevent operators from reaching the required output level Y at the minimum cost, and this may result in upward distorted costs. Firms can also undertake cost reducing activities to counterbalance their inefficiency. As already discussed, they can engage in process research and

development, managers may spend time and effort in improving the location of inputs within the network. They can as well attempt to find cheaper suppliers, bargain better procurement contracts, subcontract non-essential activities, monitor employees, solve potential conflicts, etc. Whatever these cost reducing activities may be, we will refer to them as effort. Denote by θ and e the inefficiency and effort levels of each firm, respectively. Note that these two variables are unobservable. We also allow for the possibility of technical progress, which is captured by a time trend t . Finally, as the stock of capital K is determined by the regulator, our cost function is determined in the short-run, and is conditional on the stock of capital. Each operator faces a cost function, conditional on capital, inefficiency and effort, of the form:

$$C(Y, w, K, e, \theta | \beta), \quad (1)$$

where β is a vector of parameters to be estimated. Note that, while inefficiency θ is exogenous, cost reducing effort e is a choice variable for firm i , and will therefore depend on the type of contract it faces.

We describe now the operator's effort decisions. Before entering into the analysis, it is worth reminding that the pricing structure itself is independent of the nature of regulatory incentives impinging on the activity of the firm.⁴ Thus, although prices and effort are determined simultaneously, the firms' decisions will be presented separately, for ease of exposition.

Incentives and cost reduction

This section focuses on the construction of the structural cost function. We propose to account for the regulatory incentives impinging on the operators' incentives to reduce costs through the cost function (1) that is conditional on inefficiency θ and the effort level e . Deriving the equilibrium level of effort and plugging it back into the conditional cost function allows us to derive a structural cost function that can be estimated. The aim of this approach is twofold. First, we can test whether the different transport operators are involved in different cost reduction activities, depending on which contract they face. Second, accounting for these changes in incentives through the cost structure enables us to reduce the source of misspecification, and avoid biases in the estimation of the technological parameters.

Two regulatory contracts are observed in practice, namely fixed-price and cost-plus. With the fixed-price contract, the operator is residual claimant for effort. It obtains an ex-ante subsidy t^{FP} equal to the expected balanced budget, which is the difference between expected costs and

⁴ The way we incorporate the technical inefficiency and effort parameters allows the incentive-pricing dichotomy principle to hold (Laffont and Tirole, 1993). This means that the same pricing formula applies whether we assume strong or weak competitive pressures.

expected revenue. This contract is a very high-powered incentive scheme as the operator is now responsible for insufficient revenues and cost overruns. The operator can exert effort e to reduce its operating cost C . The cost reduction activity induces an internal cost $\psi(e)$. Taking into consideration the operating cost reduction and the internal cost of effort, the operator sets the optimal effort level e that maximizes the profit:

$$U = t^{FP} + R(y) - C(Y, w, K, e, \theta | \beta) - \psi(e), \quad (2)$$

where $R(y) = p(y)y$, and θ and e are two unobservable (by the regulator and the econometrician) variables to be evaluated. Each operator determines the optimal effort level e that maximizes its profit in (2). The first order condition is:

$$-\frac{\partial C(\cdot)}{\partial e} = \psi'(e), \quad (3)$$

which implies that the optimal effort level e^{FP} equalizes marginal cost reduction and the marginal disutility of effort.

With the cost-plus contract, the public authority receives the commercial revenue $R(y)$, and receives an ex-post subsidy t^{CP} that reimburses the firm's total ex-post operational costs C . Hence, the firm is not residual claimant for effort. For this reason, this contract is a very low powered incentive scheme, as firms under this regime have no incentives to produce efficiently. The firm's utility level can be defined as

$$U = -\psi(e), \quad (4)$$

In this case, the optimal effort level is 0.

Note that considering that $e^{CP} = 0$ under cost-plus regimes is a simple normalization that we adopt for ease of exposition and tractability. We could as well assume these operators provide the minimum effort level that guarantees to some extent the renewal of the transport concession from one period to another. To be able to derive and identify two different closed forms for the cost function (1), we need to normalize $e^{CP} = 0$, and let e^{FP} be determined by Condition (3). This assumption is justifiable, given that what matters in our analysis is the difference $e^{FP} - e^{CP}$. Note that we do not force e^{FP} to be positive when estimating it.

Given these two effort levels, we can rewrite the primal cost expression in (1) as

$$C^r(Y, K, w, e^r, \theta | \beta), \quad r = \{FP, CP\}. \quad (5)$$

where r denotes the type of regulatory regime, which can be either FP or CP . Note that Equation (5) entails two different cost structures that are conditional on the observed regulatory regime.

4.2 Program of the regulator

In this section, we focus on the program of the regulator. Our aim is twofold: First, we need to express the welfare function of the regulator that we use in our logit specification at the moment of estimating the choice of contract. This entails determining carefully the different items that enter the welfare function and that can be measured with our data. Second, we propose a simple model of welfare maximization by the regulator. We show why a non-sophisticated regulator is willing to choose a cost plus or a fixed price contract depending on whether he/she has a pronounced taste for operating profits or wages.

Consider two types of non-benevolent regulators in a situation of imperfect information. Each type cares for social welfare only when it is in power (the possibility of being elected provides such incentives). The regulator cannot observe the individual θ_i but has beliefs on the distribution of θ represented by the cumulative distribution $F(\theta)$ with density $f(\theta)$ over the interval $[\underline{\theta}, \bar{\theta}]$.

Moreover, on the one hand, a type 1 regulator may attempt to capture part of the rent of the operator. If the constituency of the regulator is composed of stakeholders, it may care for the rent of the firm when in power. The regulator attaches a weight $\alpha \in \mathfrak{R}^+$ to the profit U of the firm. The regulator's utility, when in power, is then given by the following expression:

$$\begin{aligned} V^R(y, e, \theta) &= S(y) - R(y) - (1 + \lambda)(U + \psi(e) - R(y) + C(Y, e, \theta)) + \alpha U \\ &= S(y) - R(y) - (1 + \lambda)(\psi(e) - R(y) + C(Y, e, \theta)) + (\alpha - 1 - \lambda)U. \end{aligned} \quad (6)$$

Assumption 4: A right-wing government prefers to minimize the per period profit it has to give up to the operator: $\alpha \leq 1 + \lambda$.

A contract is signed over two periods. The regulator is re-elected during the second period with probability p . Hence, its utility over both periods is

$$V^R(y, e, \theta) = V_1^R(y_1, e_1, \theta) + p\delta V_2^R(y_2, e_2, \theta) + (1 - p)\delta\alpha U_2. \quad (7)$$

Thus, the regulator benefits from social welfare as long as it is in power. If it is not re-elected (with probability $1 - p$), it benefits from the profit obtained by the operator in its relationship with the next regulator. Note that the same contract is implemented from one period to the

other, since the local government is committed to it. Hence, $V_1^R(\cdot) = V_2^R(\cdot)$. Likewise, in case of a change of regulator, the new regulator cannot reduce the profit U_1 of the operator if he/she chooses to renegotiate. Hence, $U_2 \geq U_1$, i.e., the profit U_1 chosen by the first period regulator is guaranteed in the next period. To simplify, we write $U_2 = U_1$, and Equation (7) can be rewritten as

$$V^R(y, e, \theta) = (1 + p\delta)\{S(y) - R(y) - (1 + \lambda)(\psi(e) - R(y) + C(Y, e, \theta))\} + (\alpha(1 + \delta) - (1 + \lambda)(1 + p\delta))U. \quad (8)$$

Consider now a type 2 regulator who cares about workers. As suggested by Roemer and Silvestre (1992) and Pint (1991), a public authority may be willing to give the employees of the operator a worker surplus in the form of above market wages. A first reason is that the local government and the operator are assumed to respond to pressures from workers' unions. Second, the local government can be politically motivated and might consider the costs and benefits of organizing public transport only if they fall on the members of its constituency. Wages paid to the workers who reside in the constituency constitute a transfer to a subset of voters. Denote as $\beta \in \mathfrak{R}^+$ the weight attached by the regulator to the wage bill. In this case, the regulator's utility, when in power, is

$$V^L(y, e, \theta) = S(y) - R(y) - (1 + \lambda)(U + \psi(e) - R(y) + C(Y, e, \theta)) + \beta C(Y, e, \theta). \quad (9)$$

Note that since the wage bill is just a share of total costs $C(\cdot)$, the wage surplus is denoted as $\beta C(\cdot)$, where β captures at the same time the wage share in total cost as well as the taste of the regulator for the wage surplus.

Assumption 5: A left-wing government prefers to minimize the per period costs of the operator: $\beta \leq 1 + \lambda$.

As in the previous case, a contract is signed over two periods. The regulator is re-elected during the second period with probability p . Hence, its utility over both periods is

$$V^L(y, e, \theta) = V_1^L(y_1, e_1, \theta) + p\delta V_2^L(y_2, e_2, \theta) + (1 - p)\delta\beta C(Y_2, e_2, \theta). \quad (10)$$

Again, the regulator benefits from social welfare as long as it is in power. If it is not re-elected, it benefits from the cost (the wage bill) obtained by the operator in its relationship with the next regulator. As previously, the same contract is implemented from one period to the other, i.e., $V_1^L(\cdot) = V_2^L(\cdot)$. In case of a change of regulator, the new regulator cannot ask the operator to reduce its costs $C(Y_1, e_1, \theta)$. We thus write $C(Y_1, e_1, \theta) = C(Y_2, e_2, \theta)$, and Equation (10) is transformed as

$$V^L(y, e, \theta) = (1 + p\delta)\{S(y_i) - R(y_i) - (1 + \lambda)(\psi(e_i) - R(y_i))\} + \{(1 + \delta)\beta - (1 + \lambda)(1 + p\delta)\}C(Y_i, e_i, \theta) - (1 + \lambda)(1 + p\delta)U. \quad (11)$$

In a next step, we can re-write the utility of the different types of regulators as a single equation, using a parameter that controls for their political color. Let ν be a parameter that takes value 1 if the observed regulator is a left-wing type, and 0 if he/she is a right wing type. Hence, the regulator's utility is denoted as

$$V(y, e, \theta) = (1 + p\delta)\{S(y) + \lambda R(y) - (1 + \lambda)\psi(e)\} + \{\nu(1 + \delta)\beta - (1 + \lambda)(1 + p\delta)\}C(Y, e, \theta) + \{(1 - \nu)(1 + \delta)\alpha - (1 + \lambda)(1 + p\delta)\}U. \quad (12)$$

Assumption 6: Over both periods, the right-wing (left-wing resp.) regulator prefers to minimize the per period profit (operating costs resp.) of the operator:
 $\alpha, \gamma: \Delta = (1 + \lambda)(1 + p\delta)/(1 + \delta) : 1 + \lambda$

Having now the utility function of the regulator in hands, we can determine his/her objective. The regulator determines the operator's optimal effort level that maximizes the expected utility $E_\theta V(y, e, \theta)$. The reader might remember that the regulator only knows the cumulative distribution $F(\theta)$, but cannot observe the individual levels θ_i . We rule out any revelation mechanism in our maximization program for the reasons discussed in our third section. Thus, our objective function is not constrained by any incentive compatibility constraint. Note that setting an optimal effort level is equivalent to proposing a particular type of regulatory scheme to the operator. Differentiating $E_\theta V(y, e, \theta)$ with respect to e yields the following condition:

$$\psi'(\cdot) = -\left[1 - \nu \frac{\gamma}{\Delta}\right] E_\theta C_e(\cdot) + \left[(1 - \nu) \frac{\alpha}{\Delta} - 1\right] E_\theta U'. \quad (13)$$

From Equation (13), it appears that, if the regulator is left-wing ($\nu = 1$), increasing β decreases the effort e ; the regulator proposes a cost-plus contract to the operator when $\beta = \Delta = (1 + \lambda)(1 + p\delta)/(1 + \delta)$. Likewise, in case of a right-wing operator ($\nu = 0$), increasing α increases the effort e ; the regulator proposes a fixed-price contract to the operator when $\alpha = \Delta = (1 + \lambda)(1 + p\delta)/(1 + \delta)$.

Our empirical model will serve as a test of the simple theoretical predictions presented in this section. First, our econometric specification of contract choice is based on the utility function of the regulator specified in (12). A badly defined utility function will be rejected by our data at the moment of the estimation process. Second, Our theoretical prediction says that, since we observe only cost plus or fixed price contract in reality, the taste α of the right-wing

(β of the left-wing resp.) regulators for operating profit (operating costs resp.) should be closely related to the cost of public funds λ , the probability of re-election p , and the discount factor δ . Again, this can be tested with our empirical model.

5. The econometric model

The cost function

We assume a Cobb-Douglas specification for the cost function presented in (1). This specification retains the main properties desirable for a cost function, while remaining tractable. Alternative more flexible specifications, such as the translog function, lead to cumbersome computations of the first order conditions when effort is unobservable. The cost function is then specified as:

$$C = \beta_0 w_l^{\beta_l} w_m^{\beta_m} Y^{\beta_Y} K^{\beta_K} \exp[(\theta_j - e_j)], \quad (14)$$

We impose homogeneity of degree one in input prices, i.e., $\beta_l + \beta_m + \beta_Y = 1$. The reader should remember that θ and e are both unobservable. The inefficiency θ is characterized by a density function $f(\theta)$ defined over an interval $[\theta_L, \theta_U]$, where θ_L (resp. θ_U) denotes the most efficient (inefficient resp.) operator. Second, the effort e is defined as follows. Define the following convex cost of effort function, with $\psi(0) = 0$, $\psi'(e_j) > 0$, and $\psi''(e_j) > 0$:

$$\psi(e_j) = \exp(\mu e_j) - 1, \quad \mu > 0, \quad (15)$$

where μ is a parameter to be estimated. Using the functional forms of operating costs (1), the cost of effort (15), and the first order condition for effort (3), we can express the effort level under a fixed-price regulation. The first-order condition that determines the effort level e^{FP} can now be written as:

$$C(.) = \mu \exp(\mu e_j) \quad (16)$$

Substituting (14) in (16), we can solve for e^{FP} as:

$$e_j^{FP} = \frac{1}{1 + \mu} (\beta_0 + \beta_l \ln w_l + \beta_m \ln w_m + \beta_Y \ln Y + \beta_K \ln K + \theta - \ln \mu), \quad (17)$$

while $e^{CP} = 0$. As suggested by the new theory of regulation, the effort level of a firm increases with θ , i.e., a more inefficient operator optimally exerts more effort than a less inefficient operator, $\partial^2 C / \partial \theta \partial e < 0$. Moreover, operators provide less effort when effort is more costly, i.e., when the cost reducing technology parameter μ is larger. Substituting back e^{FP} and e^{CP} into (14) allows us to obtain the final forms to be estimated $C^{FP}(\cdot)$ and $C^{CP}(\cdot)$. We obtain:

$$\ln C^{FP} = c_0 + \beta'_l \ln w_l + \beta'_m \ln w_m + \beta'_k \ln K + \beta'_y \ln Y + \gamma \theta, \quad (18)$$

and

$$\ln C^{CP} = \ln \beta_0 + \beta_l \ln w_l + \beta_m \ln w_m + \beta_k \ln K + \beta_y \ln Y + \theta, \quad (19)$$

where $\gamma = \mu / (1 + \mu)$, $c_0 = \beta_0 + (1 / (1 + \mu)) (\ln \mu - \beta_0)$, and $\beta' = \gamma \beta$. It is interesting to note that $\lim_{\mu \rightarrow +\infty} \beta' = \beta$, suggesting that, as the cost of effort grows, the effort level falls, and expression (18) converges to (19). This implies that, if the effort activity in the industry is significant, and if effort is not properly identified, the estimates of the cost elasticities are biased. The cost function to be estimated is then:

$$\ln C = \xi^{FP} (c_0 + \beta'_l \ln w_l + \beta'_m \ln w_m + \beta'_k \ln K + \beta'_y \ln Y + \gamma \theta) + \xi^{CP} (\ln \beta_0 + \beta_l \ln w_l + \beta_m \ln w_m + \beta_k \ln K + \beta_y \ln Y + \theta), \quad (20)$$

where ξ^{FP} takes value 1 if the regulatory regime is of “fixed-price” type, and 0 otherwise, while ξ^{CP} takes value 1 if the regulatory regime is of “cost-plus” type and 0 otherwise. In the course of the estimation, several vectors ξ^{FP} and ξ^{CP} will be assumed, depending on which transport network is observed.

For a network i at period t , the stochastic cost function can be stated from Equation (20) as

$$C_{it} = C^r(Y_{it}, K_{it}, w_{it}, \theta_i, \xi_{it} | \beta) + \varepsilon_{it}, \quad (21)$$

where an error term ε_{it} is added to account for potential measurement errors. It is assumed to have a normal density function with mean 0 and variance $\frac{2}{c}$. Moreover, the efficiency index

has a beta density with scale parameters and . The inefficiency parameter is thus conveniently defined as a percentage. This is readily obtained since the beta density is defined over the interval $[0, 1]$. In this case, the level of effort is also defined over the unit interval since

e must be non-negative.

A logit specification for contract choice

The regulator is assumed to select the type of contract with the highest utility. Since the utilities are not known to the econometrician with certainty, they are treated as random variables. The choice probability of contract r is equal to the probability that the utility of alternative r , \bar{V}_{it}^r , is greater than or equal to the utility of the other alternative r' in the choice set $\Omega = \{FP, CP\}$. This can be written as follows:

$$P(r|\Omega) = \Pr(\bar{V}_{it}^r \geq \bar{V}_{it}^{r'}, \quad r, r' \in \{FP, CP\}) \quad (22)$$

We can express the random utility of an alternative as the sum of observable and unobservable components of the total utilities:

$$\bar{V}_{it}^r = EV(z_{it}^r, x_{it}^r) + \omega(z_{it}^r, x_{it}^r) = EV_{it}^r + \omega_{it}^r, \quad (23)$$

where z_{it}^r is a vector of contract attributes and x_{it}^r is a vector of regulators' characteristics which varies among individuals. Both contract attributes and regulators' characteristics may include components that are observable or unobservable to the econometrician. Let $E_{\theta}(\cdot)$ be written as $E(\cdot)$ for simplicity; Expression (22) can therefore be rewritten as

$$P(r|\Omega) = \Pr(EV_{it}^r + \omega_{it}^r \geq EV_{it}^{r'} + \omega_{it}^{r'}, \quad r, r' \in \{FP, CP\}), \quad (24)$$

or

$$P(r|\Omega) = \Pr(\omega_{it} = \omega_{it}^{r'} - \omega_{it}^r \leq EV_{it}^{r'} - EV_{it}^r, \quad r, r' \in \{FP, CP\}). \quad (25)$$

Assuming that $r = FP$, and $r' = CP$, expression (25) can be rewritten as

$$P(r|\Omega) = \Pr(\omega_{it} \leq \{\nu(1+\delta)\beta + (1+\lambda)(1+p\delta)\}(EC^r(Y_{it}, e_{it}^r, \theta_i) - EC^{r'}(Y_{it}, e_{it}^{r'}, \theta_i)) + \{(1-\nu)(1+\delta)\alpha - (1+\lambda)(1+p\delta)\}EU_{it}^r - (1+p\delta)(1+\lambda)\psi(e_{it}^r)). \quad (26)$$

We need now to make some assumption about the distribution of the difference between the two disturbances a_{it} . Assuming that a_{it} is logistically distributed, $P(r|\Omega)$ can be rewritten as

$$P(r|\Omega) = \frac{e^{EV_{it}^r}}{e^{EV_{it}^r} + e^{EV_{it}^{r'}}}. \quad (27)$$

The likelihood function

The likelihood of a data point conditional to θ_i is

$$L_{it}(\theta_i) = P_{it}(r|\Omega)^{\eta_{it}^r} P_{it}(r'|\Omega)^{\eta_{it}^{r'}} L(C_{it}^r | Y_{it}, K_{it}, w_{it}, \theta_i, \xi_{it}, \beta, \sigma_c, \mu, \nu), \quad (28)$$

where η_{it}^r ($\eta_{it}^{r'}$ resp.) is an indicator parameter that takes value 1 if the observed contract at date t is of type r (r' resp.), and 0 otherwise. Note that, since the variable x_{it} is unobservable, only the unconditional likelihood can be computed, i.e.,

$$L_{it} = \int_0^1 L_{it}(x_i) x_i^{\nu-1} (1-x_i)^{\gamma-1} \frac{\Gamma(\nu+\gamma)}{\Gamma(\nu)\Gamma(\gamma)} dx_i, \quad (29)$$

where $\Gamma(\cdot)$ is the gamma function. Assuming that observations are independent, then the log-likelihood function for our sample is just the sum of all individual log-likelihood functions obtained from Equation (29).

PRELIMINARY RESULTS

Variable	Parameter	I	II	III
<u>Cost Function</u>				
Constant	$\ln \beta_0$	-4.614 ^{***} (0.159)	-3.947 ^{***} (0.151)	-4.922 ^{***} (0.246)
Labor	w_l	0.312 ^{***} (0.033)	0.322 ^{***} (0.034)	0.323 ^{***} (0.035)
Output	w_Y	0.993 ^{***} (0.010)	0.985 ^{***} (0.011)	0.972 ^{***} (0.017)
Effort	$\ln \mu$			4.937 [*] (2.946)
θ 's density 1	τ		3.547 ^{***} (0.411)	3.454 ^{***} (0.544)
θ 's density 2	φ		2.378 ^{***} (0.308)	3.758 ^{***} (0.726)
Error term s.d.	c_ε	0.200 ^{***} (0.005)	0.075 ^{***} (0.016)	0.076 ^{***} (0.025)
<u>Contract Choice</u>				
Constant				-4.059 ^{***} (0.837)
Trend				0.437 ^{***} (0.117)
Right-Wing Regulator				0.348 ^{**} (0.175)
Public operator				0.734 ^{***} (0.228)
Size of the Network				0.795 ^{***} (0.160)
Keolis				-1.387 ^{***} (0.262)
Agir				-2.505 ^{***} (0.294)
Connex				-1.704 ^{***} (0.272)
Number of Observations		735	735	735

Note: Standard errors are in parenthesis.

***Significant at 1%; **Significant at 5%; *Significant at 10%.

References

- AUBERT, C. AND LAFFONT, J.J. "Political Renegotiation of Regulatory Contracts". mimeo Université Paris IX Dauphine, 2004.
- BAJARI, P., AND TADELIS S. "Incentives versus Transaction Costs: A Theory of Procurement Contracts." *Rand Journal of Economics*, Vol. 32 (2001), pp. 387-407.
- BARON, D.P., AND MYERSON, R.B. "Regulating a Monopolist with Unknown Costs." *Econometrica*, Vol. 50 (1982), pp. 911-930.
- GAGNEPAIN, P. AND IVALDI, M. "Incentive Regulatory policies: The Case of Public Transit Systems in France." *Rand Journal of Economics*, Vol. 33 (2002), pp. 605-629.
- GASMI, F., LAFFONT, J.J. AND SHARKEY, W.W. "Incentive Regulation and the Cost Structure of the Local Telephone Exchange Network." *Journal of Regulatory Analysis*, Vol. 12 (1995), pp. 5-25.
- INSTITUT D'ECONOMIE INDUSTRIELLE. "Network Industries and Public Service." *European Commission Reports and Studies*, Vol. 4 (1999).
- LAFFONT, J.J. "Industrial Policy and Politics." *International Journal of Industrial Organization*, Vol. 14 (1996), pp. 1-27.
- LAFFONT, J.J., AND TIROLE J. "Using Cost Observation to Regulate Firms." *Journal of Political Economy*, Vol. 94 (1986), pp. 614-641.
- LAFFONT, J.J., AND TIROLE, J. *A Theory of Incentives in Procurement and Regulation*. Cambridge: MIT Press, 1993.
- LOEB, M., AND MAGAT, W. "A Decentralized Method of Utility Regulation." *Journal of Law and Economics*, Vol. 22 (1979), pp. 399-404.
- PINT, E.M. "Nationalization Versus Regulation of Monopolies: The Effects of Ownership on Efficiency." *Journal of Public Economics*, Vol. 44 (1991), pp. 131-164.
- ROEMER, J.E. AND J. SILVESTRE. "A Welfare Comparison of Private and Public Monopoly." *Journal of Public Economics*, Vol. 48 (1992), pp. 67-81.
- WOLAK, F.A. "An Econometric Analysis of the Asymmetric Information Regulator-Utility Interaction." *Annales d'Economie et de Statistiques*, Vol. 34 (1994), pp. 13-69.
- WUNSCH, P. "Estimating Menus of Linear Contracts for Mass Transit Firms." mimeo, CORE, 1994.