Economies of Scope in Cost-Reduction Incentives

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Abstract

The goal of this paper is to identify and measure the relevance of economies of scope in the French urban transport industry, where most regulated transportation networks are operated by firms that belong to the same company. We build and estimate a structural cost regulation model under incomplete information where the service is regulated by an authority and is provided by a single operator that may be owned by a larger company. We identify the scope effects which arise for some operators being linked to a same group, and see how they influence the firms' decisions of exerting effort in order to reduce their operating costs. Our model provides us with estimates of the operators' inefficiencies, the effort of the managers and the scope effects. Our results show that economies of scope are indeed relevant for the existing industrial groups present in the French urban transport industry. Simulation exercises provide evidence of significant reductions in total operating cost following the enlargement of industrial groups and/or mergers between existing groups.

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1 Introduction

This goal of this paper is to identify and measure the relevance of economies of scope in the French urban transport industry. In each French city of significant size, the local authority regulates and monitors the activity of a single operator that provides the transport services on the urban network within a regulatory framework. The latter takes the form of a written contract that defines the payment and cost-reimbursement rules between the parties. Two types of regulatory contracts are observed in practice, namely fixed-price and cost-plus schemes. Under fixed-price contracts, the operator receives subsidies to cover ex-ante (expected) operating deficits, while under cost-plus regulation, subsidies are provided by the local authorities to finance ex-post (realized) deficits. As it is well known, each type of regulatory rule has an impact on operating costs since it entails different levels of incentives in terms of effort in cost reduction activities. In particular, fixed-price contracts provide powerful incentives to reduce operating costs.

The regulator does not observe the technological efficiency or the cost reduction activity of the operator. In France, local authorities have been historically blamed for their laxness in assessing operating costs, mainly because of their lack of knowledge and experience of transportation economics and technologies, and/or because of their limited capacity of monitoring and auditing complex operating activities. These considerations prevent them to adequately assess the effort of operators in providing appropriate and competent solutions to cost and network inefficiencies.

A distinguishing feature of the French urban transport industry is that about eighty percent of the operators are owned by three large companies. The transport services provided in different networks by operators belonging to the same industrial group are therefore, in essence, provided by the same firm. This peculiarity suggests that these companies may benefit from economies of scope by operating several networks in different localities. In other words, the economic activity involved in one specific network may affect the economic activity in other networks operated by the same company. In the specific context of the urban transport industry, we expect these economies of scope to take place when a cost-reducing activity developed by one of the operators reaches other parts of the group. As a consequence of this technological spillover, all networks operated by the firms belonging to the group benefit from the cost-reducing efforts provided by any of the operators. In the french urban transportation industry, operators have engineer teams in each network that are responsible for the improvement of the operator's productivity. When operators belong to the same group, the new methods and procedures that they develop can potentially be used by the entire company, therefore improving productivity and/or reducing operating costs .

This paper is aimed at identifying and measuring the importance of these economies of scope in the French urban transport industry and their impact on the efficiency of operators. Empirical studies testing the existence of economies of scope, or even the existence of positive externalities within different activities in the public urban transportation industry are rather scarce.[3] Several studies document the existence of economies of scope for multi-product firms in specific industries. For the case of local public transportation, Farsi et al. (2007) identify significant economies of scope from operating trolley-bus, motor-bus and tramway systems in the Swiss urban public transport sector. Di Giacomo and Ottoz (2007) find fixed cost savings based on economies of scope for Italian urban intercity bus transit operators. Kim (1985) shows evidence on scale and scope economies in multi-product firms in the US water sector. For the case of Italy, Fraquelli et al. (2004) document the presence of economies of scale and scope in multi-services providers of public utilities (gas, water and electricity).

We build and estimate a structural cost regulation model with asymmetric information that includes economies of scope (i.e. positive externalities) of operating different networks. Our goal is to identify the latter, and see how they influence firms' decisions of exerting effort to reduce their operating costs. Our model provides us with estimates of the firms' inefficiencies, the effort of the managers and the economies of scope.

In our model, each operator in each given city faces different incentives to reduce its operating costs. First, the type of regulatory contract (fixed-price vs cost-plus) is a crucial determinant of cost reducing activities. The second class of incentive, is the one driven by the economies of scope that follow from operators being part of a same group, if any. The econometric task consists then in recovering the parameters of a static model of cost regulation under incomplete information, and testing for the relevance of economies of scope.

[3]From a theoretical perspective, Barbosa (2010) shows that low-powered contracts arise in equilibrium due to a free-riding problem in procurement design when a contractor has economies of scope working for several buyers, thereby enjoying positive externalities when providing goods or services for different buyers.

Our results show that economies of scope are indeed relevant in the French urban transport industry.

Note that we do not model the regulation decision by the authority, i.e. we take the regulatory mechanisms as exogenously given to estimate the model's parameters.[4] Likewise, we leave dynamic considerations out of our framework. In particular, we not address the ability of the regulator to commit not to use the information on the operator's cost from one regulatory period to another.[5] Here, our aim is to focus on the economies of scope that arise from the operators' group structure within a static framework.

The organization of the paper is as follows: Section 2 describes the regulation of urban transportation in France in more detail. Section 3 presents the contracts that are implemented during our period of observation and describes the structure of the different existing industrial groups in the French urban transport industry. Section 4 discusses the assumptions that are maintained throughout the paper. Section 5 presents our model of cost regulation which encompasses the main features of urban transportation and the environment in which network operators make their decisions. Section 6 then develops a formal specification of the cost function to be estimated. Section 7 is devoted to the construction of the variables and the presentation of our results. Section 8 provides a summary and some concluding remarks.

2 The French Urban Transportation Industry

As in most countries around the world, urban transportation in France is a regulated activity. Local transportation networks cover each urban area of significant size, and for each network, a local authority (a municipality, a group of municipalities or a district) is in charge to regulate an operator which has been selected to provide the transportation service. Regulatory rules prevent the presence of several suppliers of transportation services on the same urban network, and each network is therefore operated by a single operator.

The 1982 Transportation Law was enacted to facilitate decentralized decision-making

[4]See Gagnepain and Ivaldi (2012) for a political model of regulation that incorporates the determinants of contract choices.

[5]These issues are addressed in Gagnepain et al. (forthcoming).

on urban transportation and to provide guidelines for regulation. As a result, each local authority now organizes its own transportation system by setting route and fare structures, capacity, quality of service, conditions for subsidizing the service, levels of investment and ownership nature. The local authority may decide to operate the network directly or to require the services of a transport service provider. In the latter case, a formal contract defines the regulatory rules that the operator must follow as well as the payment and/or cost-reimbursement scheme between the authority (the principal) and the operator (the agent).

In most urban areas, operating costs are on average twice as high as commercial revenues. Budgets are therefore rarely balanced without subsidies. One reason is that operators face universal service obligations and must operate in low demand areas. Low prices are maintained to ensure affordable access to all consumers of public transportation. Moreover, special fares are given to targeted groups like seniors and students. Subsidies come from the State's budget, the local authority's budget, and a special tax paid by local firms (employing more than nine full-time workers). They are not necessarily paid directly to the operator. 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. We return on these points more in detail below.

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.[6] In 2002, these companies, with their respective ownership structures and market shares (in terms of number of networks operated) were Keolis (private, 30%), Transdev (semi-public, 19%), Connex (private, 25%). In addition there are a small private group, Agir, and a few public firms controlled by local governments. The next section is dedicated to a more detailed presentation of the structure of these groups.

Our objective is to take these features of the urban transport industry into account and to perform an analysis of the observed regulatory schemes within a principal-

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

agent setting. This requires a database that provides information on both the performance and the organization of the French urban transport industry. Such a database was created in the early 1980s from an annual survey conducted by the *Centre d'Etude et de Recherche du Transport Urbain* (CERTU, Lyon) with the support of the *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. In France, this rich source is a unique tool for comparing observed regulatory schemes both across year and over time. In our econometric analysis, we consider the regulatory scheme adopted in each urban area during a year as a realization of the same regulatory contract. The sample does not include the largest networks of France, i.e., Paris, Lyon and Marseille, as they are not covered by the survey. Overall, the panel data set covers 87 different urban transport networks over the period 1987-2001.

We now turn to a more detailed description of the contractual relationships and of the urban transport group structures.

3 Regulatory Contracts and Transport Groups

Two types of regulatory contracts are implemented in the French urban transport industry, namely fixed-price and cost-plus schemes. Over the period of observation, fixed-price contracts are employed in 61% of the cases, as shown in table 1. Under fixed-price contracts, operators receive subsidies to finance the expected operating deficits, while under cost-plus schemes, subsidies are paid to the local authorities to finance ex-post deficits. Hence fixed-price regimes are very high-powered incentive schemes, while cost-plus regimes do not provide any incentives for cost reduction. For the same network, the regulatory scheme may switch from cost-plus to fixed-price or from fixed-price to cost-plus between two contract periods. We indeed count twenty-three changes of regulatory regimes, eighteen of them being switches from cost-plus to fixed-price regimes. These changes may occur either during the term of a local authority which decides for a shift in the regulatory framework, or after the election of a new local government.

As already mentioned, and as shown in table 1, about eighty percent of local transport service operators are owned by three larger industrial groups; Keolis, Connex and Transdev. Industrial groups of urban transport have a long history of mergers in France. Keolis was born out of the merger of several companies created in the beginning of the 20th century. The *Société des transports automobiles*, created in 1908, its subsidiary (the *Société générale des transports départementeaux*) and the company *Lesexel*, founded in 1911 to help on the development of tramways, merged to form the VIA-GTI company, mainly focused on urban transport. In the meantime, another company, *Cariane,* was specialized in the French interurban transport. Ultimately, VIA-GTI and *Cariane* merged in 2001 to give birth to Keolis.[7] The industrial group Connex was born out of the merger of the *Compagnie Générale Française des Transports et Entreprises* (CGFTE) and the *Compagnie Générale d'Entreprises Automobiles* (CGEA) in the late 1980's.[8] The company was ultimately renamed *Veolia Transport* in 2005. Finally, the Transdev group was created in 1955. On March 3rd 2011, it merged with *Veolia Transport* to give birth to *Veolia Transdev.*

Table 1 presents figures on the distribution of the operators in our sample according to their affiliation to one of the three groups and to the type of contract they face. While 61% of all the networks are under a FP regime, this figure amounts to 64.5% when focusing on the operators belonging to a group and to 48% for independent operators. Although it seems that belonging to a group is an important determinant of being regulated under a FP contract, a closer look at the frequency of FP contracts within groups indicates that this figure comes mainly from the Connex group, where more than 90% of the networks it operates are under a FP scheme. The overall proportion of networks operated by firms belonging to one of the three major groups is of 78.6%. For networks regulated under a FP regime, 83.1% are operated by firms belonging to a group. For networks under CP contracts, this figure amounts to 71.6%.

For each urban transport network, the automatic renewal of the contract between the local authority and the operator in place was effectively ended, by law, in 1993. Since then, local authorities are required to use beauty contests to allocate the construction and management of infrastructures of urban transportation. In practice, however, very few networks have experienced changes of operators from one regulatory period to another. Over the period covered by our analysis, only 5 networks have decided to

[7]http://www.keolis.com/en/about-us/key-facts/history.html

[8]The company actually decided to take on the name Connex in 2000. For more details, see http://www.connex.info/tmpl/ExtensionPage____2778.aspx?epslanguage=ML.

get rid of their operators to select another company. Out of these, two changed from being operated by a firm belonging to a group to a being operated by an independent firm, while only one network changed from being operated by an independent firm to being operated by a firm belonging to a group. Finally, only 2 networks saw their operator change from a firm belonging to a given group to a firm belonging to another group.

As a matter of fact, the different operators mostly avoided head to head competition and generally put tenders for markets in distinct urban areas. By committing to distinct geographical areas, the three main groups succeeded in reducing the degree of competition in the awarding of transport operations in urban areas where the regulatory contract comes to an end. Competitive tendering is therefore not a relevant issue in this sector, and ex-ante competition is not so fierce. Finally, these groups also operate other municipal services such as water distribution or garbage collection, which makes it even harder for public authorities to credibly punish operators following bad performances in the provision of transport services. It follows that group structures are rather stable both across networks and over time in our sample.

These urban transport industry features constitute the core of our analysis on the network effects among operators belonging to the same group and inspire the construction of the structural model of regulation that we present below. Before going to the construction of our economic model, we introduce some assumptions that we now present in detail.

4 Delineating the Scope of the Study

The organization and structure of the urban transportation industry in France as described above motivates the following assumptions.

Assumption 1: The network operator has private information about its technology, and the authority does not observe its effort to improve productivity or to reduce costs.

We assume that the network operator has private information about its innate technology (adverse selection) and that its cost-reducing effort is non-observable (moral hazard). Because French local authorities exercise their new powers on transportation policy since the enactment of the 1982 Law only, and since they usually face serious financial difficulties, their limited auditing capacities is recognized among practitioners. A powerful and well-performed audit system needs effort, time and money. French experts on urban transportation blame local authorities for being too lax in assessing operating costs, mainly because of a lack of knowledge of the technology.[9] The number of buses required for a specific network, the costs incurred on each route, the fuel consumption of buses (which is highly dependent on drivers' skills), the drivers' behavior toward customers, the effect of traffic congestion on costs, are all aspects for which operators have much more data and a better understanding than public authorities. This suggests the presence of adverse selection on innate technology in the first place. Given the technical complexity of these issues, it should be even harder for the local authority to assess whether and to what extent operators undertake efforts to provide appropriate and efficient management. Moral hazard arises quite naturally on top of the adverse selection problem. When compounded, those informational asymmetries play a crucial role in the design of contractual arrangements and financial objectives.[10]

Assumption 2: Regulatory schemes and operators' efficiency levels are exogenous

According to the new theory of regulation, when contractual relationships are characterized by informational asymmetries, a welfare-maximizing regulator applies the revelation principle to provide the operator with incentives to reveal its 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 his 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 (Laffont and Tirole, 1993).

Does this framework apply to the French urban transport industry? If it did, fixed-

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

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

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. It is therefore realistic to assume that regulatory schemes are not driven by the intrinsic characteristics and efficiency levels of large service companies and of network operators.

Assumption 3: An operators belonging to an industrial group benefits from the cost reducing activities of the remaining operators of the group.

We assume that operators belonging to one of the groups presented above (i.e. Keolis, Transdev or Connex) will be affected by actions taken in other networks operated by another member of the same group. In particular, we expect actions related to cost-reducing activities taken in a specific network to generate positive externality on the operating costs of the remaining operators of the group. Throughout the text, we will refer to these effects as scope effects.

In each network, the existence of inefficiencies may lead to higher operating costs than the levels defined by the cost frontier. Firms can, however, undertake cost-reducing activities to overcome these inefficiencies. They can, for instance, engage in process research and development, or managers can 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, or solve potential labor conflicts. For a given group, we assume that the effort exerted in a specific network will affect the inefficiencies of the remaining networks of the group. The results of process R&D obtained in one location can for instance be transmitted to another operator. The latter would therefore benefit from (part of) this R&D without investing as much effort as it would have to if it were independent. Similarly, the effort incurred to find a cheaper supplier in one network may reduce the need to look for a cheaper supplier in another city. The bargaining of procurement contracts may also be easier if the operator belongs to a group with relevant experience in other networks. Likewise, methods to efficiently monitor employees could also be learned in a given place and transmitted to another.

We propose to estimate a structural cost function that accounts for the regulatory scheme faced by the operator as well as for the structure of the group it belongs to, if any. This allows us to test for the relevance of scope effects among operators in the French urban transport industry.[11]

We now turn to the construction of our structural model of regulation.

5 The Economic Model

We now present our model of regulation of the urban transport industry. Starting from the technology associated with the transportation activity, we first define the primal operating cost function, which is conditional on the cost-reducing activity of the operator. We describe how the contract types and the structure of the transport groups affect the operators' choice of cost-reducing effort. Once the optimal level of effort is determined, we plug it back into the conditional cost function to obtain the final cost function that captures all the relevant incentives affecting the activity of the firm.

Technology and primal cost function

To provide the required level of services Q, the transit firm (the operator) needs to combine variable and fixed inputs. Let $w = (w_L, w_M)$ be the price of variable inputs, namely labor (L) and materials (M). Let K and I be, respectively, the stock of capital and the infrastructure used by the operator, which are both fixed in the short run. The production process is then represented with the production function $Q = f(K, I, L, M|\alpha)$, where α is a vector of parameters characterizing the technology in the production process. Note that both L and M are the efficient levels of inputs, which are only observable to

[11]Three additional remarks should be made. First, private information on demand is not a relevant issue in our industry. Local governments are well informed about the transportation needs of citizens. The number of trips performed over a certain period is easily observed, and the regulator has a very precise idea of how the socio-demographic characteristics of a urban area fluctuate over time. Given the level of demand, the regulator sets the service capacity provided by the operator. Second, we do not address the issue of determining what should be the optimal rate-of-return on capital. The rolling stock is owned by the local government for a vast majority of networks. In this case, the regulator is responsible for renewing the vehicles, as well as guaranteeing a certain level of capital quality. Finally, we rule out the possibility of risk sharing in the contractual relationships between the operators and the regulators since the provision of transport services does not entail unpredictable cost fluctuations for the operators.

the operator. We denote by C the observed operating cost of each firm. As the stock of capital K and the size of the infrastructure I are determined by the regulator, our cost function is determined in the short run, and is conditional on the stock of capital and on the size of the infrastructure.[12] Each operator chooses the cost-minimizing input allocation subject to technological constraints, which leads to a cost function of the following form:

$$C_i^0 = C_i^0(w_i, Q_i, I_i, K_i|\beta), \tag{1}$$

where β is a vector of parameters characterizing the cost function. In reality, the actual operating cost may differ from the minimum operating cost defined by (1). Inefficiencies may prevent operators from reaching the required level of service Q at the minimum cost, which will result in upward distorted costs. To counterbalance these inefficiencies however, firms can undertake cost-reducing activities. They can engage in process research and development, or managers can 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, or solve potential labor conflicts. Whatever these cost-reducing activities may be, we will refer to them as effort.

A distinguished feature of the French urban transport system is that about 80% of local operators are private and are owned by three large industrial groups. In 2002, these companies, with their respective market shares (in terms of number of networks operated) were $Keolis$ (30%), $Transdev$ (19%) and $Connex$ (25%). Hence a given firm i operating a specific network can be either independent or belong to one of these larger companies. Each of these industrial group $g = \{Keolis, Transdev, Connex\}$operates a set of urban networks $N_g = \{1, \ldots, n_g\}$. While production inputs are exclusively network specific, we expect the inefficiencies to affect all the n_g networks of a given group g. Likewise, we expect the cost-reducing efforts exerted in a given network to affect the operating cost of other firms belonging to the same industrial group. These scope effects are, however, not present for an independent operator. We return to these points more in detail below.

[12]In practice, the operator plays a role in the choice of investment, which, potentially, introduces another dimension that can be affected by information asymmetries. Our understanding of the industry is that this question is of second-order since, for instance, the production of new buses, which could have a drastic impact on the efficiency of the transport network, takes time and refers to periods longer than regulatory periods.

Denote by θ_g the inefficiency level of each of the n_g networks of group g, and let θ be the inefficiency level of an independent network. We denote the effort level of firm i belonging to group g by e_{ig}, and let e_{-ig}denote the effort of the remaining networks belonging to the same group. Let e_i be the effort level of an independent operator i. Note that both the inefficiency and the effort levels are unobservable to the regulator and to the econometrician. Each operator therefore faces a cost function which provides the frontier of minimum operating costs conditional on the levels of capital, infrastructure, inefficiency, effort and group structure. Specifically, operator i faces a cost function of the form:

$$C_i(C_i^0, \theta, e|\beta) = \begin{cases} C_i^0 \times \phi\left(\theta, e_i\right) & \text{if } i \text{ is an independent operator} \\ C_i^0 \times \phi\left(\theta_g, e_{ig}, \kappa_{ig} e_{-ig}\right) & \text{if } i \in N_g, \end{cases} \tag{2}$$

where κ_{ig} is a parameter measuring the scope effects obtained by operator i for being linked to the remaining operators belonging to group g. Notice how we define the κ_{ig} parameter to depend both on network and group characteristics, as we expect networks within a same group to benefit asymmetrically from scope effects. Note that while the inefficiency parameter θ is exogenous, the cost reducing effort is a choice variable which will depend on both the contract that the firm faces and on the structure of the group it belongs to, if any. We next turn to the operator's effort decision and to the construction of the structural cost function.

Incentives, economies of scope and the optimal level of effort

Two main aspects dictate the incentives that each operator faces to reduce costs through the conditional cost function 2. The first environment's characteristic that affects the operator's incentives to reduce its costs comes from the regulatory pressure, defined by the type of contract that the operator faces. Two regulatory contracts are observed in practice, namely fixed-price (FP) and cost-plus (CP). Under a 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 expected revenues. This contract is a very high-powered incentive scheme as the operator is now responsible for insufficient revenues and cost overruns. With the cost-plus contract, the public authority receives the commercial revenue $R(q)$, and receives an ex-post subsidy t^{CP} that reimburses the firm's total ex-post operational cost C. The firm is therefore not residual claimant for effort and this contract is a very low powered incentive scheme. Under this regime, firms have no incentives to produce efficiently. The operator can, under both types of contracts, exert effort e to reduce its operating cost C. The cost reduction activity induces an internal cost $\psi(e)$.

The second aspect of the economic environment that affects the incentives to reduce costs is whether the operator belongs to an industrial group or whether it is independent. As already mentioned, belonging to an industrial group that is present in other French cities allows an operator to benefit from the cost-reducing efforts that are exerted in these other locations. These scope effects are a central point in our model. We have in mind new methods, procedures or general knowledge that are obtained in one network and can be transmitted to another. For instance, the results of process research and development obtained in one location could help some other operator belonging to the same group in another location. The latter may therefore benefit from this R&D without investing as much effort as it would have to if it were independent. Similarly, the effort incurred to find a cheaper supplier in one network may reduce the need to look for a cheaper supplier in another city. The bargaining of procurement contracts may also be easier if the operator belongs to a group with relevant experience in other networks. Likewise, methods to efficiently monitor employees could also be learned in a given place and transmitted to another. While the necessary amount of effort to reduce inefficiencies is affected by the group structure a firm belongs to, we assume that it is still expensive to exert a given amount of effort. In other words, we assume that the marginal cost of effort is not affected by the group structure. For a given firm that belongs to group, this means that while the efforts exerted in the remaining networks will affect its operational costs, the function $\psi(e)$ will only depend on its own effort. These network effects are not present for an independent operator and its effort level will therefore only depend on the type of contract it faces.

We now explicitly take into account these incentives through the cost function (1) that is conditional on inefficiency θ and the effort level e. We first derive the optimal level of effort for each operator and check how this effort depends on the incentives mentioned above. Second, we plug back this equilibrium level of effort into the conditional cost function. This will lead us to an unconditional structural cost function that can be estimated. 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.

Each industrial group g operates a set of urban networks N_g in quantity $\text{card}\,(N_g) = n_g$. Let N_g^{fp} denote the set of networks that the group g operates under a FP contract, which entails $\text{card}\left(N_g^{fp}\right) = n_g^{fp}$ networks. Similarly, let N_g^{cp} denote the set of networks that the group g operates under a CP contract, which entails $\text{card}\left(N_g^{cp}\right) = n_g^{cp}$ networks. Hence, for each group g we have that $n_g = n_g^{fp} + n_g^{cp}$.

Under a fixed-price contract, each operator i determines the optimal effort level that maximizes the objective function

$$\pi_i = \begin{cases} t_i^{fp} + R\left(q_i\right) - C_i(C_i^0, \theta, e_i|\beta) - \psi\left(e_i, \alpha\right) & \text{if } i \text{ is independent} \\ t_i^{fp} + R\left(q_i\right) - C_i(C_i^0, \theta_g, e_{ig}, \kappa_{ig} e_{-ig}|\beta) - \psi\left(e_{ig}, \alpha\right) & \text{if } i \in N_g, \end{cases} \tag{3}$$

where $R(q) = p(q)q$ denotes revenue and q measures transport demand.[13] If the operator is independent, the optimal effort level e_i^{fp} that maximizes its profit in (3)

is determined by the following first order condition:

$$-\frac{\partial C_i(C_i^0, \theta, e_i|\beta)}{\partial e_i} = \frac{\partial \psi_i(e_i, \alpha)}{\partial e_i}, \tag{4}$$

which implies that the optimal level of effort e_i^{fp} is chosen to equalize marginal cost savings with the marginal disutility of effort.

For a firm belonging to a group, the optimal effort level will depend on the effort exerted by the remaining members of the group. Each of the networks belonging to group g that are under a FP contract satisfy the following first order conditions:

$$-\frac{\partial C_i(C_i^0, \theta_g, e_{ig}, e_{-ig}|\beta)}{\partial e_{ig}} = \frac{\partial \psi_i(e_{ig}, \alpha)}{\partial e_{ig}}, \quad \forall i \in N_g^{fp}, \tag{5}$$

[13]Note that transportation networks are industries where capacity (or supply) Q is adjusted to demand levels q. As demand fluctuates during the day, the regulator determines the minimum capacity level that covers all quantities of service demanded at any moment of the day. As capacity cannot adjust instantaneously to demand levels, the minimum capacity level is always higher than demand. Hence commercial revenues are determined by q, while costs are determined by Q.

which constitutes a system of n_g^{fp} equations. For a firm belonging to a group and under a FP contract, the optimal effort level e_{ig}^{fp} is therefore conditional on the effort e_{-ig} exerted by the other members of the set N_g:

$$e_{ig}^{fp} = e_{ig}\left(C_i^0, \theta_g, \kappa_{ig} e_{-ig} \mid \beta, \alpha\right), \quad \forall i \in N_g^{fp}. \tag{6}$$

Solving for the n_g^{fp} equations, we obtain the unconditional effort level:

$$e_{ig}^{fp} = e_{ig}\left(C_i^0, C_{-i}^0, \theta_g, \kappa_{ig}, n_g^{fp} | \beta, \alpha\right), \quad \forall i \in N_g^{fp}. \tag{7}$$

Under a cost-plus contract, each operator i determines the optimal effort level that maximizes the objective function

$$\pi_i = \begin{cases} t_i^{cp} - \psi\left(e_i, \alpha\right) & \text{if } i \text{ is independent} \\ t_i^{cp} - \psi\left(e_{ig}, \alpha\right) & \text{if } i \in N_g. \end{cases} \tag{8}$$

In this case, since positive effort is never rewarded under a CP regime, firm i will never provide any effort, irrespective of whether it belongs to a larger industrial group. Hence we have that the optimal effort level under a cost-plus contract is given by $e_{ig}^{cp} = e_i^{cp} = 0$. Note that setting the optimal effort under a CP contract to zero is a simple normalization that we adopt for ease of exposition and tractability. We could as well assume that the operators provide the minimum effort level that guarantees to some extent the renewal of the transport concession from one period to another. There is no loss of generality because what matters in our analysis is the difference $e^{fp} - e^{cp}$.

Plugging these effort levels into the conditional cost function (2) yields the unconditional cost function, namely,

$$C_i^\rho(C_i^0, \theta, e^\rho | \beta) = \begin{cases} C_i^0 \times \phi\left(\theta, e_i^\rho\right) & \text{if } i \text{ is independent} \\ C_i^0 \times \phi\left(\theta_g, e_{ig}^\rho, \kappa_{ig} e_{-ig}^\rho\right) & \text{if } i \in N_g, \end{cases} \tag{9}$$

where $\rho = \{fp, cp\}$ refers to the type of contract. For a given firm i, equation (9) therefore entails two different cost structures depending on the observed regulatory regime.

6 Econometric specification

We now turn to the econometric specification of our cost regulation framework. In order to derive the structural cost function to be estimated, we need to assume a specific functional form for the cost function in (9) and the disutility of effort $\psi_i(e)$.

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 primal cost function is therefore specified as:

$$C_i^0 = C_i^0(w_i, Q_i, I_i, K_i|\beta) = \beta_0 w_{L_i}^{\beta_L} w_{M_i}^{\beta_M} Q_i^{\beta_Q} I_i^{\beta_I} K_i^{\beta_K}. \tag{10}$$

We impose homogeneity of degree one in input prices, i.e. $\beta_L + \beta_M = 1$. In order to allow the observed cost C to deviate from the cost frontier defined by (10), we specify the function $\phi(\cdot)$ to be the exponential function, so that (2) is now specified as

$$C_i(C_i^0, \theta, e|\beta) = \begin{cases} C_i^0 \times \exp\{\theta - e_i\} & \text{if } i \text{ is independent} \\ C_i^0 \times \exp\{\theta_g - e_{ig} - \kappa_{ig} \sum_{j \neq i} e_{jg}\} & \text{if } i, j \in N_g. \end{cases} \tag{11}$$

We assume the internal cost of effort to be provided by the following convex function:

$$\psi\left(e\right) = \exp\left\{\alpha e\right\} - 1, \quad \alpha > 0, \tag{12}$$

with $\psi(0) = 0$, $\psi'(e) > 0$, and $\psi''(e) > 0$ and where α is a parameter to be estimated.

Using the specifications for the operating costs (11) and the cost of effort (12), we can solve the first order conditions defined in the previous section to express the optimal effort level for a network under a FP contract. We next determine the effort levels and the resulting unconditional cost functions for the different operators according to their group status and regulatory regimes.

Independent Operators

For an independent network i, the optimal effort level under a FP contract is given by the solution to (4) and is expressed as:

$$e_i^{fp} = \frac{1}{1+\alpha}\left(\ln(C_i^0) - \ln(\alpha) + \theta\right) \tag{13}$$

Recalling that $e_i^{cp} = 0$ and substituting back $e_i^{cp}$and e_i^{fp} into (11) allows us to obtain the final forms for the cost functions $C_i^{cp}(\cdot)$ and $C_i^{fp}(\cdot)$ to be estimated for independent operators as:

$$\ln(C_i^{fp}) = \frac{\alpha}{1+\alpha}\left[\ln(C_i^0) + \theta\right] + \frac{1}{1+\alpha}\ln(\alpha) \tag{14}$$

and

$$\ln(C_i^{cp}) = \ln(C_i^0) + \theta. \tag{15}$$

Note that equation (14) corresponds to the expression of the Cobb-Douglas cost function which is usually estimated, i.e. when moral hazard in the form of presence of an effort activity is not taken into account. Note also that $\lim_{\alpha\to+\infty} \ln(C_i^{fp}) = \ln(C_i^{cp})$, since the effort level under a FP contract converges to 0 when the cost-reducing technology parameter α becomes infinitely large. This also translates into a lower effect of the inefficiency θ on the final costs of operator i when the cost of exerting effort is lower.

Operators Belonging to Industrial Groups

If a network i belongs to a group and is under a FP contract, it will benefit from its own cost reducing activity and from the efforts of the $n_g^{fp} - 1$ remaining operators that belong to the same group and that are regulated under a fixed-price regimes as well.[14] Thus, for any industrial group g where $n_g^{fp} \geq 2$ and for any $i,\ j \in N_g^{fp}$:

[14]Recall from (8) that firms under a CP contract never exert any effort in equilibrium.

$$
\begin{aligned}
e_{ig}^{fp} \quad = \quad & \frac{1}{\left(1+\alpha+\left(n_g^{fp}-1\right)\kappa_{ig}\right)} \times \left[\frac{\left(1+\alpha+\left(n_g^{fp}-2\right)\kappa_{ig}\right)}{(1+\alpha-\kappa_{ig})}\ln(C_i^0)\right. \\
& \left. -\frac{\kappa_{ig}}{(1+\alpha-\kappa_{ig})}\sum_{j\neq i}\ln(C_j^0)+(\theta_g-\ln(\alpha))\right]. \qquad (16)
\end{aligned}
$$

Notice how, for firm i, e_{ig}^{fp} now depends on the components defining the cost frontiers of the remaining networks of the group, $\sum_{j\neq i}\ln C_j^0$. Plugging the optimal efforts and (16) back into the cost function (11) allows us to obtain the final form for the cost functions $C_{ig}^{fp}(\cdot)$ to be estimated.[15] Hence if operator i is under a FP contract and belongs to a group g where $n_g^{fp} \geq 2$, then, $\forall\ j \in N_g^{fp}$, the final form for the cost function is given by:

$$
\begin{aligned}
\ln(C_{ig}^{fp}) \quad = \quad & \frac{\alpha}{\left(1+\alpha+\left(n_g^{fp}-1\right)\kappa_{ig}\right)} \left[\frac{\left(1+\alpha+\left(n_g^{fp}-2\right)\kappa_{ig}\right)}{(1+\alpha-\kappa_{ig})}\ln(C_i^0)\right. \\
& \left. -\frac{\kappa_{ig}}{(1+\alpha-\kappa_{ig})}\sum_{j\neq i}\ln(C_j^0)+\theta_g\right] + \frac{1+(n_g^{fp}-1)\kappa_{ig}}{1+\alpha+\left(n_g^{fp}-1\right)\kappa_{ig}}\ln(\alpha). \qquad (17)
\end{aligned}
$$

Note how the group inefficiency θ_g is reduced by the scope effects parameter κ_{ig}. When the latter grows larger, the efforts provided in the remaining networks of the group have a larger effect on the reduction of the inefficiencies.[16] Likewise, the negative effect of the inefficiency parameter is reduced when the number of FP networks within the group, n_g^{fp}, increases, as operator i can benefit from the efforts of a larger number of operators. Note also that $\lim_{\kappa_{ig}\to 0}\ln(C_{ig}^{fp}) = \ln(C_i^{fp})$, as network i only benefits from its own efforts when scope effects are absent.

Recall that a network regulated under a cost-plus regime will never provide any effort, irrespective of whether it belongs to a group or not. However, if firm i belongs to group g, it will still benefit from the efforts e_{ig}^{fp} provided by the n_g^{fp} remaining operators which belong to the same industrial group and are regulated under a fixed-price

[15]Note that it could also be the case that firm i belongs to a group and is the only operator under a FP contract. In this case the cost function to be estimated would result in (14) since no other firm in the group would exert any effort. However, we do not observe such cases in our data.

[16]The coefficient on the $\theta_g$parameter is decreasing in κ_{ig} : $\frac{\partial}{\partial\kappa_{ig}}\left[\frac{\alpha}{1+\alpha+(n_g^{fp}-1)\kappa_{ig}}\right] < 0$.

regime. Thus if operator i is under a CP contract and belongs to a group g where $n_g^{fp} \geq 1$, then the effort in the n_g^{fp} remaining networks is as in (16) and, $\forall\, j \in N_g^{fp}$, the final form for the cost function is given by :

$$\ln(C_{ig}^{cp}) = \ln(C_i^0) + \frac{1}{\left(1+\alpha+\left(n_g^{fp}-1\right)\kappa_{ig}\right)}\left[-\kappa_{ig}\sum_{j\neq i}\ln(C_j^0) + (1+\alpha-\kappa_{ig})\,\theta_g + n_g^{fp}\kappa_{ig}\ln(\alpha)\right]. \tag{18}$$

Again, the effect of the group inefficiency parameter θ_g is decreasing in the scope effects parameter $\kappa_{ig}$and in the number of FP networks within the group, n_g^{fp}.

Scope Effects

We expect the different networks belonging to group g to benefit asymmetrically from the scope effects captured in the κ_{ig}, depending on several characteristics. Not every operator within a group can equally benefit from the effort exerted by other operators of the group. In particular, how much an operator will benefit from the effort of other operators will depend on how "close" they are. On the one hand, we might expect that similar networks are more likely to benefit from each other's effort. On the other hand, an operator may have more to learn and to gain from the efforts of the remaining networks in their group. Recall that the only networks that will put effort to reduce their operating costs are the networks regulated under a FP scheme. Hence, we consider that the extent to which a given operator can benefit from scope effects will depend on its similarity to the average operator under a FP contract within its group. To account for these considerations, we proxy the parameter κ_{ig} to be a function of several explanatory variables which account for the characteristics of the operator, the characteristics of the network where the service is provided and the characteristics of the group g it belongs to:

$$\kappa_{ig} = \kappa\left(\gamma_g, \delta_i, DIF_{i-g}^{x}\right), \tag{19}$$

where γ_g is a group fixed effect and δ_i is a firm fixed effect. DIF_{i-g}^{x} is an index which measures structural differences in the x characteristic between the observed firm i and the average firm under a FP contract $\overline{g}_{fp}$ in group g.

In our estimations, we focus on the sample containing FP networks only. That is, for a network i in period t, we estimate the cost function:

$$\ln(C_{it}^{fp}) = \xi_{it}^{G} \ln(C_{igt}^{fp}) + \xi_{it}^{I} \ln(C_{it}^{fp}) + \varepsilon_{it}, \tag{20}$$

where ξ_{it}^{G} takes value 1 if operator i belongs to one of the three main industrial groups, and 0 otherwise, while ξ_{it}^{I} takes value 1 if operator i is independent, and 0 otherwise. The error term ε_{it} accounts for potential measurement errors and is distributed according to a normal density function with mean 0 and variance σ_{ε}^{2}.

7 Results

We present the estimation results of our model which are obtained by estimating the structural cost function (20) by maximum likelihood. We first comment the construction of the variables that enter the model.

7.1 Data and Variables

Different types of variables are required in order to identify our model. The cost equation calls for covariates that capture elements of the economic environment. Concerning the scope effects, we need variables that capture both group-specific and network-specific characteristics. Summary statistics are given in table 2, where we distinguish operators according to their group affiliation.

Estimating the Cobb-Douglas cost function requires information on the level of operating costs, the quantity of output, capital, and the input prices. Total costs C are defined as the sum of labor and material costs. Output Q is measured by the number of seatkilometers, i.e., the number of seats available in all components of rolling stock times the total number of kilometers traveled on all routes. In other words, this measure accounts for the length of the network, the frequency of the service and the size of the fleet. Note that this is also a measure of the quality of service. Capital K , which plays the role of a fixed input in our short-run cost function, is measured by the size of the rolling stock, which is the total number of seats available. Infrastructure I, which also plays the role of a fixed input, is measured by the total length of the transport network in kilometers. Since the authority owns the capital, the operators do not incur capital costs. The average wage rate w_l is obtained by dividing total labor costs by the annual number of employees. The price of materials w_m has been constructed as the average fuel price for France (published by OECD).

Estimating the scope effects requires observations on the characteristics of the operators, as well as on the features of the networks in which they operate and of the group they belong to, if any. We construct a dummy variable for each specific network and another dummy for each one of the three industrial groups (Connex, Keolis and Transdev). In order to take into account for the fact that different operators from the same group may benefit asymmetrically from scope effects, we construct a measure of the structural differences between a given firm and the average firm in the group. In particular, we define the index DIF^x_{i-g} to be a measure of the difference in the x characteristic between the observed firm i and the average firm under a FP contract in group g, $\bar{x}^{fp}_g$:

$$DIF^x_{i-g} = \frac{|x_{ig} - \bar{x}^{fp}_g|}{x_{ig}}.$$

In our estimations we consider different variables in order to calculate this index. In particular, we will focus on structural differences in the share of drivers, the total number of lines and the length of the network. The share of drivers is obtained by dividing the number of drivers in each network by the total labor force, which entails the bus drivers as well as engineers who are responsible for the improvement of the operator's productivity. The size of the network is measured as the total length of the transport network in kilometers. Note that this variable is also a proxy for the size of the operator.

7.2 Results

We turn now to the empirical results of our estimations. Table 3 displays the estimates of three alternative specifications. In each of them, we consider only networks regulated under FP contracts and test different explanatory variables that are used as proxies for the firm-specific scope effects within each of the industrial groups, κ_{ig}. We specify the function κ in (19) to have a quadratic form in all specifications. The function includes a full set of firm-specific dummy variables to control for unobserved network-specific characteristics as well as group-specific dummy variables to control for unobserved group characteristics. In other words, we specify the function in (19) to take the following form:

$$\kappa_{ig} = \left(\gamma_g + \delta_i + \mu DIF^x_{i-g}\right)^2 . \tag{21}$$

As already mentioned in section 5, we consider the operator's technological know-how, captured by the inefficiency parameter θ_g in equation (17), to be group-specific. Indeed, each one of the operators belonging to group g possesses a team of engineers which is responsible for research development, quality control, maintenance, and efficiency of the network. We consider that their knowledge capacity is determined at the group level rather than being independently determined. The group specific dummy variables γ_g measure group g's capacity to transmit knowledge among the different operators belonging to the group. As an example, consider the firms operating the transport services int the French cities of Lille and Lyon, both belonging to the Keolis group. If the mechanic team in Lyon develops a new method for repairing its light rail, part of this knowledge is reached by Keolis' mechanic team in Lille.[17] The coefficients on the γ_g dummy variables allow the different groups to have different capabilities in this knowledge transmission and capture these group-specific effects. In specification I, the structural difference between a given firm and the average firm under a FP contract in the group, DIF^x_{i-g}, is measured using the size of the network (the total length in kilometers). We compute this index using the total number of lines operated by the firm and the share of drivers in specification II and III, respectively.

Consider first the estimates related to the output and input variables in table 3. All parameter are significant at the 1% level and have the expected sign. Note that the parameter are very stable across each specification. The disutility of effort parameter, α, is also positive and significant in the three specifications, although marginally so in specification III.

The effect of our different similarity indexes on the scope effects parameter are significant in the 3 specifications. In particular, we find a positive effect of the difference in the share of drivers on the within group scope effects. This means that a lower difference in the endowment of skills (as proxied by a larger difference in the share of

[17] This example is drawn from Barbosa (2010).

drivers) implies a higher capacity to absorb the efforts exerted in the remaining FP network of the group. The effects are lower in absolute value in specifications I and II.

The estimates of the technological know-how, captured by the group dummy variables θ_g appear positive and highly significant. Irrespective of the specification, Keolis appears to be the most efficient group, followed by Connex and Transdev. Finally, it is interesting to note that the differences in the coefficients on the group dummy variables entering the scope effects parameter, γ_g. The latter appear to be negative for each group, although it is much larger in absolute value for Connex in the three specifications. It therefore seems that compared to Transdev and Keolis, Connex has the lowest capacity to transmit knowledge among its operators.

Evaluating Scope Effects

Having these estimates in hands, we are able to derive the estimated $\hat{\kappa}_{ig}$ for each network at each period. In order to test the relevance of the scope effects in our regulation model, we compute an average value of the scope effects parameter for each of the three different groups. Table 4 presents the results derived from each of our specifications. The estimates show statistically significant scope effects, confirming our hypothesis that operators belonging to a same group benefit from the efforts exerted by all the networks of the group. Our results also present differences across groups, with slightly larger scope effects for the Connex and Transdev groups.

8 Simulations

The resulting estimates of our structural model of regulation allow us to produce a series of counterfactual exercises. The effect of adding extra operators to a group on the final operating costs of the group members is of particular interest. Indeed, if we expect companies to benefit from economies of scope, operating extra networks should help in reducing the costs of operators already in place. Another counterfactual of interest is to see what would be the effect of a merger between two groups. While such an event will undoubtedly reduce competition in the industry, it could nonetheless be beneficial if it leads to important cost reductions due to economies of scope. In what follows we propose to simulate such counterfactuals in order to illustrate the potential impacts of scope effects in the French transport industry. We start by analyzing the effects of adding new operators to the existing groups.

8.1 Group expansion

Our model predicts that a given operator i belonging to a given group g will benefit from the efforts exerted by the remaining firms in the group through the scope effects parameter κ_{ig}. We have already evaluated the marginal effect of an increase in the scope effects. We now focus our attention on the effect of increasing the number of operators in a given group, while maintaining the scope effects parameter constant. To do this, we consider a hypothetical scenario where a new operator is added to a given group and compute the cost difference resulting from that change in the group structure. We perform our simulation exercise as follows. We start by considering each operator to be the only member of its group. That is, if for example operators A originally belongs to Keolis, we consider that it is now part of a new group composed of only 1 network (namely, itself) . Under this hypothetical situation, we compute the total operating cost for each operator in the sample. The next step consists in evaluating the cost change that each operator would face if a new network were added to its respective group (which, so far, consisted in only 1 network). From our cost function in (17), we compute the total cost associated with the operator belonging to a group composed of 2 networks. We assume the operator that is added to the group to be the representative operator of the group to which the initial network belongs. Following the example above, we would therefore add to the group of operator A (initially composed of only 1 network) an operator that is representative of the Keolis group (i.e. an operator characterized by the average values of the operators from Keolis).[18] Similarly, and using the same reasoning, we can compute the effect of adding a larger number of networks into the group. Once the simulation exercise is completed, we can easily compute the cost differential associated with the increasing in group size from x to $x+p$ operators. That is, we can compute $\triangle_{xp}C_{ig}^{fp} \equiv \left(C_{ig}^{fp} \mid n_g^{fp} = x+p\right) - \left(C_{ig}^{fp} \mid n_g^{fp} = x\right)$ for $x,\ p = \{1, 2, 3, \ldots\}$.

Tables 5 to 7 present the results of this simulation exercise using the estimates

[18]Note that for any operator i that belongs to group g, the variable DIF_{i-g}^{x} is unaffected by the addition of an operator that is representative of the existing firms already in the group. It follows that the scope effects parameter κ_{ig} is unaffected by such a change.

derived from specification III.[19] Results show significant costs reductions from being linked to a larger number of networks. In particular, the cost savings are increasing importantly with the number of operators that are added to the group. Note also that the effect of an additional network varies in function of the initial group size. Although to a small extent, the cost reduction associated with an extra operator is decreasing in the size of the group. Finally, note that the different groups benefit from the inclusion of additional operators to different extents. In accordance to the scope effects presented in table 4, Connex and Transdev benefit the most from scope effects.

8.2 Merger

A already mentioned, industrial groups of urban transport have a long history of mergers in France. The last merger that was witnessed in the French transport industry occurred on March 3rd 2011 and involved *Veolia Transport* (the former Connex) and Transdev, which gave birth to *Veolia Transdev*. Our model allows us to simulate such a merger and to evaluate the potential gains in costs for the merging groups, namely Connex and Transdev. Several assumption must be made on the post merger outcomes regarding our parameters. We first assume that the technological know-how of the group resulting from the merger (Veolia Transdev in our example) will take the value of the most efficient merging group. In other words, we assume that the less efficient group is absorbed by the most efficient one. In all of our estimations above, the estimated parameters $\hat{\theta}_g$ show that Connex is the most efficient group of the two since $\hat{\theta}_{Transdev} > \hat{\theta}_{Connex}$. We therefore assume that $\theta_{VeoliaTransdev} = \theta_{Connex}$ in our simulations. Similarly, we assume that, after the merger, the capacity to transmit knowledge within the group will be the highest of the two merging groups. In all of our estimations results, the estimated parameters $\hat{\gamma}_g$ show that Transdev has the highest capacity to transmit knowledge among its operators since $\hat{\gamma}_{Transdev} > \hat{\gamma}_{Connex}$. We therefore assume that $\gamma_{VeoliaTransdev} = \gamma_{Transdev}$ in our simulations. Finally, note the difference between this simulation exercise and the one we carried in the previous section. In the latter, we computed the cost reduction associated with an increase in the group size while maintaining the scope effect parameter κ constant. Here, κ will also change as a result of the merger since the operators entering the new group are not necessarily rep-

[19]The simulations based on the estimates derived from specifications I and II show similar results.

resentative of the ones already in place within the group.[20] Table 8 presents the results of the merger simulation exercise using the estimates derived from each of our specifications. For each one of the merging groups, each cell in the table presents the average percentage change in the operators' costs following the merger. The results are very similar across each specification and show important gains in costs from the merger. In particular, cost reductions are very important for operators initially belonging to the Connex group, sometimes twice as large as the cost reductions for operators initially belonging to Transdev. These results therefore confirm the importance of considering the structure of the industrial transportation groups at the time of evaluating mergers. While it will no doubt decrease competition in the industry, a merger will also bring important benefits in the form of total cost reductions following the existence of economies of scope.

9 Conclusion

In this paper we identify and measure the relevance of economies of scope in urban transport regulation. We take advantage of a specific feature of the French urban transport industry, namely that about eighty percent of the operators that provide the transport services in each city are owned by three large industrial groups. The transport services provided in different networks by operators belonging to the same industrial group are therefore essentially provided by the same firm. On top of that, the activity of every network is regulated by a local authority within a specific regulatory framework. The latter takes the form of a written contract that can be, in practice, either cost-plus or fixed-price. While effort to compensate technological inefficiencies is not rewarded under a cost-plus contract, fixed-price contracts provides powerful incentives to reduce operating costs.

When operators belong to a same group, the new methods and procedures that they develop can potentially be used by the entire company. We build and estimate a structural cost regulation model with asymmetric information that includes economies of scope of operating different networks. By focusing our analysis on operators regulated under fixed-price contracts, we ask whether their linkage through a larger group

[20] Recall that the simulation exercise in section 8.1 was realized by adding representative operators to a group, maintaining constant the DIF^{x}_{i-g} variable throughout the exercise (see footnote 18).

helps them further reduce their operating costs.

Our results show statistically significant scope effects, confirming the existence of relevant economies of scope in the French public urban transportation industry. Furthermore, several simulation exercises derived from our estimates show that operators gain significantly from being linked to a larger number of networks within a group. In particular, the cost reductions following the addition of new operators into a group is increasing in the number of networks added. Finally, the simulation of a merger between the Connex and Transdev groups, as actually occurred on March 3rd 2011, show important costs reductions for the operators involved, between 24% and 49%. Our results therefore provide evidence on the importance of taking economies of scope into account when evaluating the economic effects of mergers.

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Table 1: Characteristics of regulatory contracts and group affiliation.

Variable Name	Frequency	Percent
Networks	87	
Networks under FP contract		61.0
Belongs to a group if under FP contract		83.1
Changes in contract type	23	
Changes from CP to FP	18	
Changes of operator	5	
Changes from group operator to indep. operator	2	
Changes from indep. operator to group operator	1	
changes from group operator to group operator	2	
Operator belongs to a group		78.6
FP if operator belongs to a group		64.5
Operator is independent		21.4
FP if operator is independent		48.2
Operator belongs to Keolis		410
FP if operator belongs to Keolis		51.7
Operator belongs to Transdev		269
FP if operator belongs to Transdev		90.7
Operator belongs to Connex		241
FP if operator belongs to Connex		56.9

Note: CP refers to cost-plus contracts and FP refers to fixed price contracts

Table 2: Summary statistics by type of operator

		Type of operator			
		Belongs to group		Independent	
Name	Variable	Mean	Std dev.	Mean	Std dev.
Cost (Euros)	C	18157.23	26883.30	6473.55	5261.45
Revenue (Euros)	$R(q)$	8400.05	13322.25	2765.65	2299.52
Production (Seat-kilometers)	Q	579178.70	748774.50	240941.80	181420.00
Wage (Euros)	w_L	29.66	5.72	29.11	6.36
Price of materials (Index)	w_M	1.17	0.20	1.18	0.20
Size of the network (Kil.)	$length$	256.05	223.84	153.51	87.49
% of drivers in the labor force	$Drive$	0.72	0.08	0.74	0.07

Note: Group refer to operators belonging to either Keolis, Transdev or Connex.

Table 3: Structural Estimation Results

Name	Parameter	I	II	III
Constant		-3.648^{***}	-3.683^{***}	-3.684^{***}
		(0.112)	(0.106)	(0.109)
Connex	θ_{Connex}	0.545^{***}	0.503^{***}	0.522^{***}
		(0.063)	(0.052)	(0.052)
Keolis	θ_{Keolis}	0.418^{***}	0.375^{***}	0.374^{***}
		(0.044)	(0.0343)	(0.046)
Transdev	$\theta_{Transdev}$	0.630^{***}	0.583^{***}	0.607^{***}
		(0.057)	(0.052)	(0.053)
Wage	β_L	0.279^{***}	0.280^{***}	0.273^{***}
		(0.041)	(0.033)	(0.034)
Production	β_Q	1.042^{***}	1.013^{***}	1.059^{***}
		(0.199)	(0.129)	(0.148)
Infrastructure	β_I	0.124^{***}	0.147^{***}	0.145^{**}
		(0.023)	(0.021)	(0.021)
Cost of effort	$\ln(\alpha)$	1.719	1.867^{**}	1.624^{**}
		(1.053)	(0.794)	(0.708)
Connex	γ_{Connex}	-0.242^{**}	-0.234^{***}	-0.225^{***}
		(0.112)	(0.082)	(0.070)
Keolis	γ_{Keolis}	-0.119^{*}	-0.056^{**}	-0.068^{**}
		(0.069)	(0.028)	(0.031)
Trans	γ_{Trans}	-0.121	-0.056^{*}	-0.076*
		(0.074)	(0.029)	(0.039)
Dif Length	DIF_{i-g}^{Len}	0.008^{**}		
		(0.003)		
Dif Lines	DIF_{i-g}^{Lin}		-0.009^{*}	
			(0.005)	
Dif Drivers	DIF_{i-g}^{Dri}			0.072^{***}
				(0.024)
Stand. Dev. error	σ_ϵ	0.102^{***}	0.104^{***}	0.104^{***}
		(0.003)	(0.003)	(0.003)
Firms fixed effects	δ_i	*yes*	*yes*	*yes*
Number of observations		714	714	714

Note: Standard errors in parenthesis. ***: Significant at 1%, **: Significant at 5%, *: Significant at 10%.

Table 4: Average Scope Effects by Group

	Specification		
Group	I	II	III
Connex	0.017	0.019	0.015
	(0.001)	(0.001)	(0.001)
Keolis	0.007	0.007	0.005
	(0.000)	(0.000)	(0.000)
Transdev	0.014	0.015	0.012
	(0.000)	(0.000)	(0.000)

Note: Each cell represents the average scope effects of the corresponding group, computed as $\bar{\kappa}_g = \frac{1}{n_g^{fp}} \sum_{i \in g} \hat{\kappa}_{ig}$. Standard errors are in parenthesis.

Table 5: Percentage change in total costs from adding new operators for Connex

		... to $x+p$ operators in the Connex group								
		2	3	4	5	6	7	8	9	10
Going from x operators...	1	−4.51	−8.58	−12.28	−15.65	−18.74	−21.58	−24.19	−26.62	−28.86
		(0.317)	(0.587)	(0.821)	(1.023)	(1.120)	(1.353)	(1.488)	(1.608)	(1.715)
	2	-	−4.40	−8.39	−12.03	−15.35	−18.40	−21.21	−23.80	−26.21
		-	(0.306)	(0.568)	(0.796)	(0.994)	(1.167)	(1.319)	(1.454)	(1.573)
	3	-	-	−4.30	−8.22	−11.79	−15.06	−18.07	−20.85	−23.42
		-	-	(0.295)	(0.550)	(0.772)	(0.966)	(1.136)	(1.287)	(1.420)
	4	-	-	-	−4.21	−8.04	−11.56	−14.78	−17.75	−20.50
		-	-	-	(0.285)	(0.533)	(0.749)	(0.939)	(1.107)	(1.255)
	5	-	-	-	-	−4.12	−7.88	−11.33	−14.51	−17.44
		-	-	-	-	(0.276)	(0.516)	(0.728)	(0.914)	(1.078)
	6	-	-	-	-	-	−4.03	−7.72	−11.11	−14.25
		-	-	-	-	-	(0.267)	(0.501)	(0.707)	(0.889)
	7	-	-	-	-	-	-	−3.94	−7.57	−10.90
		-	-	-	-	-	-	(0.258)	(0.486)	(0.687)
	8	-	-	-	-	-	-	-	−3.863	−7.419
		-	-	-	-	-	-	-	(0.250)	(0.472)
	9	-	-	-	-	-	-	-	-	−3.784
		-	-	-	-	-	-	-	-	(0.243)

Note: Each cell in the table presents the average percentage change in costs following the addition of p networks to a group in which x operators are already present: $\triangle_{xp} C_{ig}^{fp} \equiv \left[\frac{\left(C_{ig}^{fp} | n_g^{fp} = x+p\right) - \left(C_{ig}^{fp} | n_g^{fp} = x\right)}{\left(C_{ig}^{fp} | n_g^{fp} = x\right)} \right] \times 100$, using equation (17) in the text. E.g. the cell corresponding to row 2 and column 7 give the percentage change in the cost of an operator that goes from belonging to a group of 2 operators to a group of 7 operators. Standard errors in parenthesis. Estimates are computed from the results obtained in specification III.

Table 6: Percentage change in total costs from adding new operators for Keolis

		... to $x+p$ operators in the Keolis group								
		2	3	4	5	6	7	8	9	10
Going from x operators...	1	−1.62	−3.17	−4.66	−6.09	−7.47	−8.79	−10.06	−11.29	−12.48
		(0.112)	(0.216)	(0.313)	(0.403)	(0.487)	(0.565)	(0.639)	(0.708)	(0.773)
	2	-	−1.60	−3.14	−4.62	−6.04	−7.40	−8.72	−9.98	−11.21
		-	(0.110)	(0.213)	(0.308)	(0.397)	(0.480)	(0.557)	(0.630)	(0.699)
	3	-	-	−1.59	−3.11	−4.58	−5.99	−7.34	−8.65	−9.90
		-	-	(0.109)	(0.209)	(0.303)	(0.391)	(0.473)	(0.550)	(0.622)
	4	-	-	-	−1.57	−3.08	−4.54	−5.93	−7.28	−8.58
		-	-	-	(0.107)	(0.206)	(0.298)	(0.385)	(0.466)	(0.542)
	5	-	-	-	-	−1.56	−3.06	−4.50	−5.88	−7.22
		-	-	-	-	(0.105)	(0.203)	(0.294)	(0.379)	(0.459)
	6	-	-	-	-	-	−1.54	−3.03	−4.46	−5.83
		-	-	-	-	-	(0.103)	(0.199)	(0.289)	(0.374)
	7	-	-	-	-	-	-	−1.53	−3.00	−4.42
		-	-	-	-	-	-	(0.101)	(0.196)	(0.285)
	8	-	-	-	-	-	-	-	−1.52	−2.98
		-	-	-	-	-	-	-	(0.100)	(0.193)
	9	-	-	-	-	-	-	-	-	−1.50
		-	-	-	-	-	-	-	-	(0.098)

Note: Each cell in the table presents the average percentage change in costs following the addition of p networks to a group in which x operators are already present: $\triangle_{xp}C_{ig}^{fp} \equiv \left[\frac{\left(C_{ig}^{fp}|n_g^{fp}=x+p\right)-\left(C_{ig}^{fp}|n_g^{fp}=x\right)}{\left(C_{ig}^{fp}|n_g^{fp}=x\right)}\right] \times 100$, using equation (17) in the text. E.g. the cell corresponding to row 2 and column 7 give the percentage change in the cost of an operator that goes from belonging to a group of 2 operators to a group of 7 operators. Standard errors in parenthesis. Estimates are computed from the results obtained in specification III.

Table 7: Percentage change in total costs from adding new operators for Transdev

Going from x operators...		... to $x+p$ operators in the Transdev group								
		2	3	4	5	6	7	8	9	10
	1	-3.77	-7.29	-10.58	-13.66	-16.54	-19.25	-21.80	-24.20	-26.46
		(0.151)	(0.288)	(0.412)	(0.525)	(0.627)	(0.720)	(0.804)	(0.881)	(0.952)
	2	-	-3.71	-7.18	-10.42	-13.47	-16.32	-19.00	-21.53	-23.90
		-	(0.148)	(0.282)	(0.404)	(0.514)	(0.615)	(0.706)	(0.790)	(0.866)
	3	-	-	-3.66	-7.08	-10.28	-13.28	-16.10	-18.76	-21.26
		-	-	(0.145)	(0.276)	(0.395)	(0.504)	(0.603)	(0.693)	(0.776)
	4	-	-	-	-3.60	-6.97	-10.13	-13.10	-15.89	-18.52
		-	-	-	(0.142)	(0.270)	(0.387)	(0.494)	(0.592)	(0.681)
	5	-	-	-	-	-3.546	-6.87	-9.99	-12.92	-15.68
		-	-	-	-	(0.139)	(0.265)	(0.380)	(0.485)	(0.581)
	6	-	-	-	-	-	-3.49	-6.77	-9.85	-12.75
		-	-	-	-	-	(0.136)	(0.259)	(0.372)	(0.475)
	7	-	-	-	-	-	-	-3.44	-6.67	-9.71
		-	-	-	-	-	-	(0.133)	(0.254)	(0.365)
	8	-	-	-	-	-	-	-	-3.39	-6.58
		-	-	-	-	-	-	-	(0.130)	(0.249)
	9	-	-	-	-	-	-	-	-	-3.34
		-	-	-	-	-	-	-	-	(0.127)

Note: Each cell in the table presents the average percentage change in costs following the addition of p networks to a group in which x operators are already present: $\triangle_{xp} C_{ig}^{fp} \equiv \left[\frac{\left(C_{ig}^{fp} | n_g^{fp} = x+p\right) - \left(C_{ig}^{fp} | n_g^{fp} = x\right)}{\left(C_{ig}^{fp} | n_g^{fp} = x\right)} \right] \times 100$, using equation (17) in the text. E.g. the cell corresponding to row 2 and column 7 give the percentage change in the cost of an operator that goes from belonging to a group of 2 operators to a group of 7 operators. Standard errors in parenthesis. Estimates are computed from the results obtained in specification III.

Table 8: Percentage changes in total costs after merger

	Specification		
Group	I	II	III
Connex	-49.28 (4.632)	-44.66 (6.334)	-43.18 (4.398)
Transdev	-23.88 (0.779)	-25.47 (0.824)	-24.02 (0.763)

Note: Each cell gives the average percentage change in the total costs of the operators of the corresponding merging group. Standard errors are in parenthesis.