Contractual Choices and Technical Efficiency in Public Procurement: The Case of Regional Railway Transport in France

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Abstract

This paper contributes to the analysis of the impact of contractual design on the performance in public procurement. It focuses on the case of railway regional transport in France, where the regions were given the prerogatives of transport organising authorities in 2002. One specificity of the sector is that the twenty regional transport authorities have to delegate the operation to the regional branches of a state-owned monopoly. This sector gives an opportunity to study public procurement in a non-contestable market and to contribute on the literature on efficiency benchmarking in regulated industries.

We rely on a stochastic cost frontier model to examine the technical efficiency of the regional branches of the national incumbent using an original panel dataset on the twenty contracts covering the period between 2009 and 2012. The empirical results highlight, in particular, how market structure alters the incentive properties of contracts: our estimations indicate indeed that the technical efficiency decreases during the contract execution. We assume that this result is, at least to some extent, one consequence of the non-contestable nature of the market.

Keywords: Contractual Choices, Incentive Regulation, Stochastic Frontier Analysis, Rail Transport.
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1 Introduction

In a context of major reforms that have been characterizing regulated industries, a number of theoretical and empirical developments have examined the effect of contractual choices on performances (Sappington [2002] or Joskow [2005]). Surprisingly, less attention has been paid to the rail transport sector although it forms an interesting ground to contribute to this question. Our objective in this paper is thus to fill this gap by analysing the case of the regional rail transport sector in France.

The recent changes in the regional railway sector in France makes it indeed an interesting case to study the impact of contractual design choices on performances. Indeed, in a global movement towards more decentralized public policy decisions in France, the regions (*i.e* the largest administrative division in France) have become responsible for organizing public transport on their territory since 2002. Each of the 20 regions now award directly and for a limited time a Public Service Obligation (PSO) contract to an operator to run its railway services. But since the incumbent (SNCF) still benefits from a legal monopoly when it comes to running national passenger services, the operator is by law a regional branch of the state owned monopoly. Given that the regions do not have either the possibility to operate the service in house, the market is non-contestable, despite the fact that procurement contracts are set out as in some other local public services in France.

This setting has led the regions to design contractual schemes to regulate the public service. Our objective is to investigate how the design of the contracts affects the performance of the regional operators and to examine the dynamic of performance, taking into account the peculiarities of the market. Recent studies have assessed the role of regulatory schemes on the cost efficiency of the operator in the transport sector as in Gagnepain and Ivaldi [2002], Dalen and Gómez-Lobo [2003] or Gautier and Yvrande-Billon [2013]. The latter two dealing as well with the dynamics of cost reduction during the course of the contract. The scope of our paper is different given the structure of the market we analyse. We indeed focus on the strategy of a single firm facing multiple contracts in the context of a non-contestable market. In such a context, our objective is to examine the impact of the market structure on the dynamics of the cost reduction efforts. For that purpose, we rely on an original dataset gathering information on regional contracts over the period 2009-2012 and the cost efficiency is assessed with a stochastic cost frontier analysis.

A second objective of the paper is to contribute to the literature on performance measurement in the downstream side of the railway sector in a situation where the market is vertically separated. The literature on rail transport has often considered the performance of the sector as a whole and less attention has been paid to the performance of rail services' operations.

First, our estimations' results exhibit differences in efficiency amongst the regional companies of the incumbent, thus corroborating the intuition that efficiency benchmarking is of relevance in the sector. Second, our results indicate that the contractual schemes do not produce the expected effect in terms of cost reduction incentives as the increase of the share of cost under a revenue cap mechanism decreases the efficiency. At last, our result highlight that the efficiency is decreasing during the contract, which we attribute, at least party, to the non-contestable nature of the market.

The paper is organised as follows. In section 1 the paper provides a description of the regional railway transport sector in France. Section 2 presents the testable propositions regarding the impact of the contract's design on the technical efficiency. In section 3 we develop our empirical strategy and present the original dataset used for the estimations. In section 4 we present and discuss the empirical results before concluding in section 5.

2 Regional railway transport in France and contracts' specificities

The regions (*i.e* the largest administrative division in France[1]) have become responsible for organizing public transport on their territory since 2002 and the law called SRU[2]. The transport services encompass suburban and intercity trains, inside the region as well as with neighbouring regions in some cases. Each of the 20 regions now award directly and for a limited time a Public Service Obligation (PSO from now on) contract to an operator to run its railway services. Yet, since the incumbent (SNCF) still benefits from a legal monopoly[3] when it comes to running national passenger services, the operator is by law a regional branch of the state owned monopoly. Given that the regions do not have either the possibility to put the contract to competitive tendering or to operate the service in

[1] The average surface area is 26,000 km^2.

[2] "*Loi relative à la solidarité et au renouvellement urbains*" - SRU - (Law n° 2000-1208 of December 13^{th}, 2000).

[3] "*Loi d'orientation des transports intérieurs*" - LOTI - (Law n° 1982-1153 of December, 30^{th} 1982) consecrates in the article 18 the monopoly of SNCF for passenger services.

house, the market is non-contestable despite the fact that procurement contracts are set out. The permanence of this situation is not ensured, since the fourth railway package[4] could open the market to competition in the coming decade. The fourth railway package should be the final step to the process of competition reforms that the European Commission started in 1991. This would of course be a major reform for competition policy in a sector that has been the preserve of publicly owned monopolies.

The new organisation of the sector has triggered a higher provision of services for regional public transport since 2002. As reported in the Haenel [2008] report the number of train-kilometres has increased by 30% between 2002 and 2012 and the number of passenger-kilometres has increased by 51% as well. This is mainly due to the fact that the regions have both increased the supply of services and have put in place their own pricing strategy on the travel cards. Therefore the expansion of regional railway transport has had a cost for the transport organizing authorities since their contribution has increased by 96% during the same period which is a result of the cost increase of new services and often lower prices for the customers. The regional railway transport has become an increasingly subsidized sector over the years: the commercial revenues cover on average less than 30% of the operating expenditures[5]. The overall budget for PSOs contracts added up to 2.8 billion Euros in 2012 and represented on average 18% of the budget of the regions[6], which makes it on average their second largest budget item after education which represents on average 3 billion Euros per year.

The design of the contracts is overall the same between the 20 regions. The operator of the PSO contracts is in charge of all the operations regarding the service, that is operating and maintaining the rolling stocks and supplying the energy (fuel and electricity). Is outside the scope of the contract the management of the rail network which is, since 1997, managed by a separate entity[7]. Regarding the commercialization of the service, the operator is also in charge of selling the tickets, collecting the revenues from fares and enforcing ticket checks on board. The staff necessary to run the services is formed of employees of the operator. The staff for operating and maintaining the trains is usually employed at a

[4] The fourth railway package refers to a bundle of European legislation regulating the railway sector that should soon be adopted.

[5] Source: *Ville Rail et Transport* magazine.

[6] Website of the *Association des Régions de France.*

[7] Between 1997 and 2015, the infrastructure manager was an independent firm called RFF. Since the beginning of 2015, the railway sector has vertically re-integrated in France following a legislative bill on the sector past in 2014. The infrastructure manager is now affiliated to the incumbent under the name SNCF Réseau.

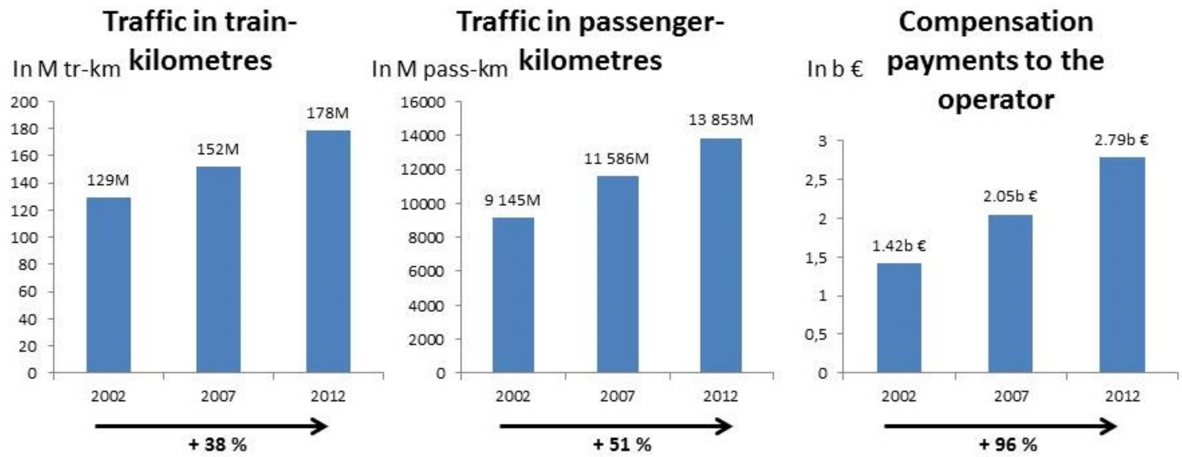

Figure 1: Evolution of the scope of PSO contracts in regional transport since the 2002 decentralisation

corporate level, while the staff in charge of commercializing the service is employed by the regional entity and are specific to one region. Regarding the rolling stocks, it is owned by the operator although the regions subsidize the whole cost of purchasing the new rolling stocks. The rolling stocks are attached to one transport authority, but can occasionally be redeployed in another region when operating the services requires it. The rolling stock is thus not a highly specific phsycial asset within this market.

The transport authorities do not make use of their entire prerogatives regarding commercialization of the services. The regions do have the responsibility to set the price of travel cards for daily commuters but the basic level of fares is set at a national level and approved by the ministry of transport. The regions delegate to the operator the aspects of communication to customers and marketing activities. The transport authorities do not make use as well of their right to order train paths, leaving it to the operator. This enables the state incumbent to design a service consistent with its national trains, and in particular to create a network of connecting trains to service the smaller urban areas.

Regarding the financial transfers between the two contractors, it is worth noting that the regional operator receives each year a compensation from the region which is equal to the difference between operating costs[8] and revenues from fares. On average, the revenues from fares appear to cover only 27% of the costs in our database. Thus and as already mentioned, the financing of the rail transport services depends heavily on the compensa-

[8] Investments are treated on a separated account. The only capital expenditures are the rolling stocks when they have not been fully paid by the regional authorities.

tion payments made by the regional authorities.

The regime applied to costs is the same across contracts where two types of costs are defined: the non-controllable costs and the controllable costs. The non-controllable costs are transferred each year *ad valorem* to the region by the operator. They encompass all the non-controllable costs such as infrastructure charges, taxes and amortisation of capital. The controllable costs, on the other hand, are under a cap. They include, in particular, the operation and maintenance of rolling stocks, the energy consumption, expenditures for operating the train stations and commercializing the service. The evolution of controllable costs during the contract is set according to a cost index. The benefits of the operator are set as a percentage of these costs and they range from 0.8% to 3.7% as described in the contracts.

Setting the initial cost base requires a strong audit capacity on behalf of the regions. In the recent years, the regions have often stressed issues related to asymmetric information and, as a reaction, audits have been order to better understand the billing of the operator[9] and to better assess its performance, in the absence of competitive pressure and benchmarking tools that could enlighten them on the subject. We were made aware that the regional transport authorities have a limited access to information on costs and it is uneasy for them to verify how far the costs correspond to an economic reality for the operator. Our understanding is therefore that the transport authorities have a limited bargaining power when they set the initial amount of expenditures included in the cap. The cap is not set in stone for the duration of the contract and does not evolve solely according to the cost index formula. As we will develop later on, renegotiations take place in particular when regions want to change the initial transport service during the contract (and, as far as we know, this situation is quite frequent in the sector). Except for one region (to our knowledge) which has instated a flat rate per train kilometre in case of a new service, the other 19 regions have to engage in a negotiation based on a cost estimate issued at the operator's discretion. Some contracts have also an explicit provision to renegotiate the overall cost base of the cap halfway through the execution of the contract that may trigger an evolution of the cap different from one defined in the cost index formula.

Another common feature on the contracts is that the operator is in charge of collecting the revenues from fares. Those fares are subject to yearly objectives set together by the regions and the operator. A risk sharing mechanism exists to deal with the situation

[9]The *Lorraine* region ordered for instance an audit in June 2013.

where the operator over performs or under performs compared to the defined objective. As mentioned earlier, the operator does not have the liberty to set fares at the level it wishes. The levers available to the operator to stimulate demand are the quality and the the marketing of service, or it may strengthen the ticket control on board the trains to decrease its loss caused by fraud.

In our view, and as it will be developed later on, the compensation payment transferred by the regions each year to the operator could be seen as the result of two bargaining games between the operator and the region : the first one occurs at the beginning of the contract and the second occurs arise during renegotiations.

To conclude this section, it is worth noting that the contractual schemes exhibit the characteristics of a net cost contract since the operator assumes the production risk (on cost) and part of the commercial risk (on revenues). One should therefore underline that, on the contrary to other sectors (see, for example, Roy and Yvrande-Billon [2007]) we do not find a diversity of contractual schemes in the regional public transport: the organizing authorities rely on the same contract design. The implications of this contractual choice on the performance of the operators are developed in the following sections.

3 Theoretical framework and testable propositions

3.1 Assessing the relative performance

From an agency perspective, the regions regulating a PSO contract are faced with two types of information asymmetries: regarding the productivity of the incumbent on the one hand and, on the other hand, regarding the unobservable effort for reducing the operating expenditures. On this matter, Auriol [2000] stresses that " *a clever way to reduce information asymmetries consist in using the existing correlation between firms producing the same type of product or services. In which case we assume they are facing the same costs or at least comparable costs. Even if the regulator does not know the true value of these costs, it can use this common structure to overcome its informational disadvantage and be a step closer to social optimum. This is what we call yardstick competition*[10]."

[10] *"Une facon astucieuse de réduire les asymétries informationnelles consiste à exploiter la corrélation qui existe entre des entreprises produisant le même type de bien ou de service. On suppose dans ce cas qu'elles font face au mÃªme coût ou du moins des coûts comparables. Meme si le régulateur ignore la valeur de ces coûts il lui est possible exploiter leur structure commune pour surmonter son désavantage informationnel et se rapprocher de l'optimum social. C'est ce qu'on appelle la concurrence par comparaison."*

In the recent years, the regions have multiplied the initiatives to make the performance of the operator more comparable. Amongst those initiatives, an interesting one has emerged from the *Associations des Régions de France* which is used in the transport sector as a platform to share best practices. The output of the collaboration has been a common base of indicators which led to the publication of rankings, with an important focus on service quality. Also this platform led to the production of reports on the best practices to monitor and enforce the PSO contracts. Those are positive steps in the transition from passive monitoring of the contract to a more active monitoring of the PSO operator. Yet, no formal regulation mechanism based on the performance of the operator has emerged from this collaboration as of this day.

Such a mechanism would require as a prerequisite for the regulator to specify its objective function. In our view, a reasonable objective for regional authorities would be to minimize production costs for a given level of service (routes, frequencies) defined in the contract. It is to be noted that an underlying associated assumption of this objective is the exogeneity of the output. An output such as train-kilometres can however be considered exogenous given that the service is characterized by a public service obligation (in this sector, it has been defined as "*a requirement defined or determined by a competent authority in order to ensure public passenger transport services in the general interest*" according to the European legislation[11]). The cost minimizing objective is rather straightforward given the hard budget constraint that public administrations usually face.

Besides, using cost minimization as a tool to examine PSO contracts is consistent with the mechanism set out by Shleifer [1985] in its seminal article. Shleifer [1985] defined a regulation mechanism where the optimal payments made to a firm depend on cost comparison with other comparable firms under the jurisdiction of the regulator. From a theoretical point of view, the effort made by firms to reduce their costs should be greater when facing yardstick competition than with a more traditional regulation.

Despite the fact that regulation based on relative performance has been less developed compared to other sector such as the electricity (Jamasb and Pollitt [2000]) or the telecommunication sectors (Resende [2008]) there are documented successful applications in public

[11] Article 2 of Regulation (EC) n°1370/2007 of the European Parliament and of the Council of 23 October 2007 on public passenger transport services by rail and by road and repealing Council Regulations (EEC) n° 1191/69 and 1107/70.

transport. For instance, as described by Mizutani et al. [2009], it has been implemented in the railway sector in Japan where there is no local competition but 14 local vertical monopolies. The regulator in charge of reviewing the fares has set up several performance measures, one of them being targeted at assessing operating costs. According to the relative performance of firms, the regulator then decides to validate or not the fares level. According to Mizutani et al. [2009] this mechanism has had very positive results since yardstick competition led to a 12.4% decrease of variable costs.

A second application to a comparable sector is described by Dalen and Gómez-Lobo [2003] in Norway for the regulation of bus services. Similarly to the French case, the responsibility for local transport has been decentralized. As pointed out by the authors, the counties adopted a cost model, applying it to all companies within a county in order to determine the annual transfers. The threat of tendering network services alone allowed some counties to put in place a subsidy cap. And this threat seems to have been enough since during the 10 years period of their study yardstick type contract helped reduce cost inefficiency faster where it was implemented and only 1.7% of the total production was subject to competitive tendering in the end.

As pointed out by Lévêque [2004] who has applied to the regional rail transport sector the theoretical and empirical tools developed for yardstick regulation, we believe also that the comparison of the regional entities can be used to assess the performance of each PSO contract. One of the reason lies in the fact that the heterogeneity of firms is not a constraint because regional contracts are awarded to the divisions of a unique company: the incumbent SNCF. Even if that company gives managerial freedom to the local operators, the productive structure should be the same, and therefore there would be homogeneity amongst decision making units. Yet, due to the period studied in Lévêque [2004] (before the contracts where put in place), the author was not able to ascertain the effects of contractual schemes on the optimization strategy of regional sub companies. We believe our paper lies in the continuity of Lévêque [2004] but, as the data we gathered covers a period of time when the PSO contracts are in place, we are able to examine the dynamics of contracts and their incentive properties, as we will develop later on. In that context, our objective is to test whether the efficiency differences can be attributed to different cost reduction efforts and not only to varying operating conditions. In other words, an objective of the paper is to analyse how far any departure from the objective of the transport authority (*i.e.* minimize production costs given a certain level of output) can be explained by strategic behaviours of the operator, focusing on the ones that stem from the design of the contract, as described in the following subsection.

3.2 Testable propositions

Theoretical developments consider that the regulatory options for a regulator range from a cost plus contract to a fixed-price contract. The public procurement literature highlights that they differ by their incentive and adaptive properties (Laffont and Tirole [1993], Bajari and Tadelis [2001]). When studying the case of public transport contracts in France, Roy and Yvrande-Billon [2007] suggest further refinement in the classification of contracts by introducing a difference between a gross cost contract and a net cost contract as subcategories of fixed-price contracts. In a gross cost contract, the transfer from the transport authority to the operator is independent from commercial revenues: the operator bears only the production risk on costs, as opposed to a net cost contract where the operator bears both the production and commercial risks (in a fixed-price contract, the operator is in charge of collecting the traffic receipts and the transfer from the transport authority is fixed *ex ante*).

In the case of rail regional transport in France, the payments scheme was set the same way across the regions and, at first glance, it has the flavour of a fixed-price contract. The transfer payments (T) by the regions can indeed be described as follows:

$$T = C1 + C2 - R$$

- *C1* are the controllable costs subject to a cap set at the beginning of the regulation period with its indexation formula defined for the duration of the contract;
- *C2* are the non-controllable costs billed *ad valorem*;
- R are the commercial revenues which are a function of a yearly objective and the realized revenues.

Many articles have insisted on the importance of the design of contracts on the efficiency of the operator. In the public procurement literature it is often assumed as in Laffont and Tirole [1993] that the cost of the operator depends on its innate efficiency θ and the effort of cost reduction e such that the cost of the operator is $C = \theta - e$. Fixed-price contracts are deemed to create more incentives to reduce costs (*i.e.* to increase the parameter e) because, on the contrary to a cost plus scheme, operator's profits depend on its ability to lower its level of costs during the duration of the contracts as described in Cabral and Riordan [1989]. On the other hand those contracts are supposed to leave a rent to the operator whose innate efficiency θ is higher. A regulator might be reluctant to do so given the cost of public funds. From an empirical stand point, Gagnepain and Ivaldi [2002], Piacenza [2006] and Roy and Yvrande-Billon [2007] corroborate the predictions on the impact of high powered incentive schemes on technical efficiency in the urban public transport sector.

Thus the design of the PSO contracts, close to a net cost contract, should set incentives for the operator to reduce its costs in regional rail transport. Yet, the contracts depart actually from the standards on several matters. First, as far as we know, the commercial revenues objectives are usually negotiated *ex ante* on a yearly basis and therefore not set in stone for the duration of the contracts. Second, in case the yearly objectives are not met, the difference is distributed between both contractors using a risk sharing mechanism specified in the contract. Depending on the percentage of deviation from the revenue target, the contracts specify which contractor has to bear the difference. The modalities of the risk sharing mechanism vary from one region to another in particular with respect to the threshold that leads to a renegotiation of the initial objectives. In the end, we assume that there is no strong commitment on commercial revenues objectives that covers the whole regulation period and the yearly deviation are subject to a risk sharing mechanism. As consequence, our opinion is that operator bears only a small part of the commercial risk.

The cap on controllable costs can also be subject to renegotiations during the contract. Those negotiations will occur, in particular, when there is a need to to change the nature of the service, whether the situation is lasting (the transport authority may for example decide to open a new route) or temporary (this is for example the case when a route has to be closed temporary after heavy maintenance was decided on the network or when a train is cancelled due to operational difficulties). Some contractual clauses also allow renegotiating in the situation where the economic equilibrium of the contract changes (although, to our opinion, the notion of economic equilibrium is not precisely specified in the contract). In the end, we assume that the yearly evolution of the controllable costs does not follow strictly the indexation formula set at the beginning of the contract but is rather the result of a negotiation between the two parties.

In a fixed-price contract, the effectiveness of cost reduction incentives is mainly driven by the fact that profits are not captured by the regulator during the contractual period.

In our sector, our intuition is that the yearly renegotiations could be interpreted as a consequence of a rather limited regulatory commitment during the contract as described in Guasch et al. [2008]. Should the regulator be able to properly monitor the production costs, then the yearly negotiations on the variations of the compensation payments (which could be interpreted, in practice, as an adjustment variable) are an opportunity to adjust the revenue cap on the level of real costs. In such a context, our interpretation is that the operator cannot expect cost reductions to generate as much profits. This is all the more the case since PSO contracts remunerate the operator as a percentage of the controllable costs, similarly to cost plus regimes. As a consequence, the profits of the operator depend on its overall level of costs and not solely on its ability to reduce its costs under the target set in the contract. To our opinion, this provision may dull as well the incentive of the operator to reduce its costs. Furthermore, the design of the contracts may also create an adverse effect: the operator may increase its costs when the contract is negotiated if banking on the cost plus dimension on the contract is deemed more profitable than the net benefits of reducing ones costs. The payment scheme would then lead to an Averch and Johnson [1962] effect on the controllable costs. This effect should be intensified by the percentage of remuneration that is granted to the operator at the beginning of the contract.

A second drawback relates to the ability of the regulator to assess the innate efficiency of the operator. In the case of rail regional transport, the informational constraints the regulators face makes setting the initial cap particularly challenging. Glachant et al. [2012] insist on the fact that the choice of the regulatory scheme should be in line with the expertise of the regulator. Given that the regions have less than 10 years of experience regulating PSO contracts and limited understanding of the cost structure, a fixed-price contract can be a complicated contract to set in place. Despite a common design of the contracts, the proportion at the beginning of the contract of controllable costs that are subject to a revenue cap and to a percentage of remuneration ranges from 67% to 85% of the overall costs from one region to another. This heterogeneity can stem from the ownership structure of rolling stocks[12] which we could unfortunately not control. If the regional operators have similar cost structures then the heterogeneity of expenditures subject to a revenue cap should be the result of its ability to cover up its innate cost structure by decreasing its technical efficiency. We therefore assume that this ratio can be used as a proxy of the bargaining power of the operator at the time the contract is signed. This

[12] Depending on whether the rolling stock has been fully subsidies by the region, partly subsidies by the region (in which case the amortisation of rolling stock is covered as a non-controllable cost) or is rented by the operator to the transport authority (in which case it is considered a controllable cost), this ratio should vary.

bargaining power may last throughout the contract and translate into a lower technical efficiency. We assume that such a strategy results, at least to some extent, from the absence of competition and outside sources of comparison.

Those two issues lead us to take the view that the contract design does not solve the moral hazard issue. The payment scheme does not creates incentives to exert a greater effort nor does it help much the regulator to learn the innate cost structure of the operator. The revenue cap on controllable costs can have a negative effect on the efficiency of the operator if it is more profitable for the operator to retain a high level of controllable costs. Given these developments, our first proposition is the following:

Proposition 1: *The higher the percentage of remuneration on controllable costs subject to a cap, the lower the technical efficiency of the regional operator.*

The length of the contracts varies from 6 to 10 years depending on the region. Our understanding is that the length depends, on the one hand, on political cycles and, on the other hand, on bargaining games between operators and regions. Therefore, despite the first contracts having been signed in 2002 in all the regions[13], the contracts are at different point in time over the period we study (2009 - 2012) as pointed out in figure 2. This makes it possible to study the dynamics of cost reduction during the contracts and check if there is a common pattern across all contracts.

The evolution of the controllable costs is theoretically subject to an indexation formula, which should create incentives to cost reduction efforts. Yet, as it has been pointed out earlier, those costs are subject to frequent renegotiations every year. The transport authority can appreciate the profits of the operator *via* the operating statements and results which the operator is obligated to pass every year. If the operator is generating profits, then we can assume that those *ex post* renegotiation will become harder for him to handle. A limited regulatory commitment makes it difficult for the operator to maintain a high deviation between its realized costs and the costs set it the contract, hence to generate high profits throughout the length of the contract. Therefore we assume that the evolution of contractual costs we study follows roughly the same pattern as the realized costs of the operator as the regulator should be able to capture the efficiency gains over the next couple of years.

[13] Six regions took part of an experimentation process which led to a first set of contracts being signed in 1996 and 1997.

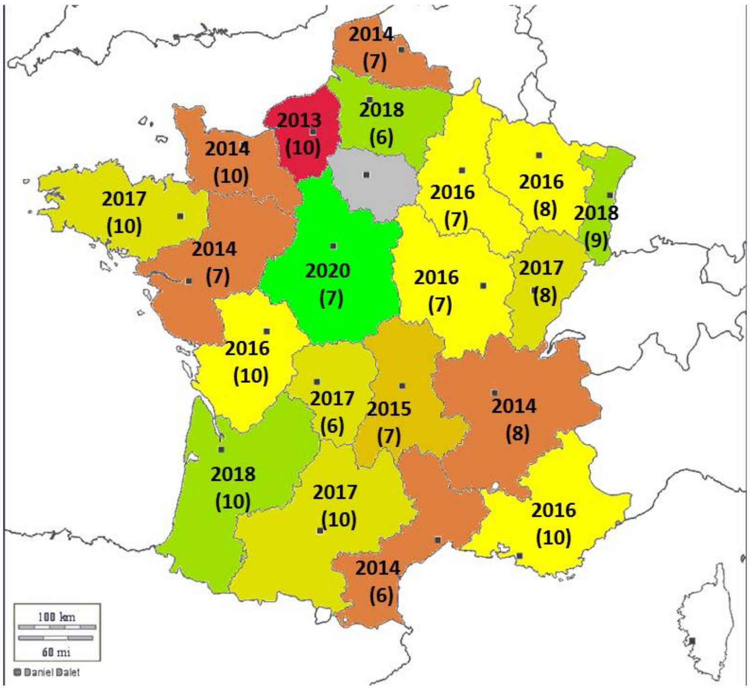

Figure 2: Contracts termination in our database (year 2012)

A key feature of the case we study stems from the fact that the market is not-contestable. In our view, this specificity has two potential consequences on the dynamic of cost reduction incentives. First, if the operator applies a discount factor on its cash flows, the existence of a revenue cap on part of the costs should create an incentive to reduce its costs at the beginning of the contract. This intuition is summed up by Joskow [2005]: "*A dollar of cost savings in year 1 is worth much more to the firm than a dollar of cost savings in year 5*". Firms have an incentive to make a greater effort of cost reduction at the beginning of the contract if they can benefit from a rent over a longer period of time, before the regions try to appropriate part of the rent they generated. In the case of urban public transport Gautier and Yvrande-Billon [2013] showed empirically that the profit flow is a source of incentive for reducing costs at the beginning of the contract.

A second phenomenon when studying the dynamics of cost reduction in the literature on procurement is that the perspective of seeing the contract being renewed should be an incentive to increase cost reduction towards the end of the contract. In other words, the operator in place should increase its technical efficiency at the end of the contract to maximize the odds of being re-conducted. The results of Gautier and Yvrande-Billon [2013] find it to be corroborated in the case of public urban transport in France. In the case of regional railway transport in France, we assume that this incentive plays no role since the probability of not being renewed is null and there is no possibility to operate the service in house for the transport authority. Therefore one should observe that the cost reduction efforts arise only at the beginning of the contract.

Furthermore, the design of the contracts might create an adverse effect to increase production costs toward the end of the period. The economic literature on the dynamics of efforts shows that the players anticipate that they will be evaluated mainly on their recent performance due to the fact that it is considered more representative (see, for example, Fudenberg and Tirole [1995]). Fudenberg and Tirole [1995] highlight in particular that there may be room for self-sabotage when the incentive to smooth the performance presented to shareholders is important. In the case of public procurement Iossa and Rey [2014] and Affuso and Newbery [2000] also expect that renewal decision are mainly based on recent performance. This creates an incentive for the firm to make a greater effort towards the end of the contract and not during the contract since past performance is of little relevance when negotiating the contract. Given the negotiation process we have described earlier in the French regional railway transport, the operator can anticipate as well that the transport authority will use recent performance as a basis to negotiate the upcoming contract. Yet, since the contracts are automatically renewed, the operator can adopt a strategy where it exhibits a higher degree of technical inefficiency at the end of the contracts. This strategy would lead potentially to a greater rent during the next contract, overcoming the loss incurred to adopt such a strategy. In other words, the fact that the market is not contestable creates a potential ratchet effect on the performance of the operator as described by Weitzman [1980]. Those arguments lead us to our second theoretical proposition:

Proposition 2: *The technical efficiency is decreasing during the time of the contract: the closer the end of the contract is, the lower the technical efficiency.*

4 Empirical model

4.1 A stochastic cost frontier approach

To test our theoretical predictions, we use an original dataset on the 20 French regions between 2009 and 2012 which is 7 years after they became transport organizing authorities. It is worth noting that during the period, no institutional or organisational reform took place in the railway sector, making the comparison more comfortable. During the time period we study, each region was at least running its second PSO contract with the incumbent. The descriptive statistics of the variables we use can be found in table 1.

To measure the technical efficiency of regional operators, we rely on a stochastic frontier analysis [14] (SFA). Since the seminal paper by Farell [1957], this method has been enriched on numerous occasions (Kumbhakar and Lovell [2001]).

This method has, in particular, been used to measure the technical efficiency in the railway sector (Mizutani et al. [2009], Lévêque [2004]). Most studies have focused on assessing the performance of the overall railway sector, (*i.e.* the management of the infrastructure and the operation of transport services) and less on the performance of solely the downstream market. It is also to be noted that stochastic frontier analysis has also been frequently used to measure the performance of the urban transport services (Piacenza [2006], Gautier and Yvrande-Billon [2013]).

An usual presentation of a stochastic cost frontier model is as follows:

$$C_{it} = f(Y_{it};\beta).TE_{it} \tag{1}$$

Where C_{it}, Y_{it} and β stand respectively for the cost level, the vector of outputs of firm i $(i = 1, 2, ..., I)$ at the period t and the vector of parameters to be estimated. The term TE_{it} represents the technical efficiency of the operator i at date t, that is to say the ratio between the minimum level of cost that could be obtained for given outputs and inputs' prices. As a consequence:

$$C_{it} \prec f(Y_{it};\beta) \text{ and } TE_{it} \prec 1.$$

One of the peculiarities of parametric models rely in the need to specify a functional form which necessarily imposes constraints on estimation results. In this paper, we choose the log linear Cobb-Douglas cost functional form. A TransLog cost function could be more appropriate as it is a more flexible form: the TransLog function imposes indeed less restrictions on the substitutability of inputs. One of the perks of the Translog functional form is that it gives information on the return to scale as discussed in the railway sector in Wheat and Smith [2015]. Yet, such a specification would require a greater number

[14]Non parametric modelling such as *Data Envelopment Analysis* (DEA) is also commonly used in the literature to measure performance. A survey on the merits and disadvantage of the two methods can be found in Coelli et al. [2005] and Coelli et al. [2003]. In our case, the SFA methodology was more relevant to test our theoretical propositions as we will develop later on.

of degrees of freedom which we cannot afford given the limited size of our sample (see Urdanoz and Vibes [2013] for a discussion on this topic). The Cobb-Douglas function has also already been used in the railway sector such as Farsi et al. [2005] in Switzerland, Mizutani et al. [2009] in Japan and Lévêque [2004] in France.

Rewriting equation (1), the cost frontier to be estimated can be written as follows, in the case of a Cobb-Douglas production technology:

$$\ln C_{it} = \beta_0 + \beta_1 \ln Y_{it} + \sum_{n=1}^{N} \beta_n \ln Yc_{nit} + \sum_{n=1}^{M} \beta_n \ln X_{mit} + \epsilon_{it}, \tag{2}$$

where:

$$TE_{it} = e^{\epsilon_{it}}.$$

C_{it} is the cost variable, Y_{it} the output, Yc_{it} a vector of N output characteristics, X_{it} a vector M of environmental variables and ϵ_{it} the error term. The introduction of a vector on output characteristics is suggested in Mizutani and Uranishi [2013] when assessing the relative performance of railway sectors in OECD countries. It is to be noted that the variables we consider as output characteristics may be treated as control variables in other empirical studies (see for example Smith and Wheat [2012]).

The cost variable. The variable we use is the net contribution of the regions, *i.e.* the cost billed each year minus the commercial revenues of the service. We consider the net contribution of regions to be relevant for our analysis since it is the variable the regions base their decision on and it is consistent with PSO contracts where the objective of the regulator is to provide a certain quantity of service to users under a budget constraint. It is worth noting that our variable depends on the commercial revenues generated by the service but, as mentioned, the pricing strategy is outside of the control of regional operators. Therefore, variations of commercial revenues are mostly dependent on the ability of the regional operator to optimize and market the service.

The output. The indicator we use to quantify the production of the regional companies of the incumbent is the vehicle-kilometres (*TRKM*). As pointed out in figure 3, there is a large heterogeneity in the size of the contracts. This variable is communally used in empirical studies focusing on the public transport sector (Lévêque [2004], Farsi et al. [2005] and in urban transport Berechman [1993], Kerstens [1996], Dalen and Gómez-Lobo [2002], Piacenza [2006], Roy and Yvrande-Billon [2007]). One of the advantages of this supply-oriented variable is that, for a large part, it can be considered as exogenous to the extent that the expected service level is defined *ex ante* in the contractual agreement.

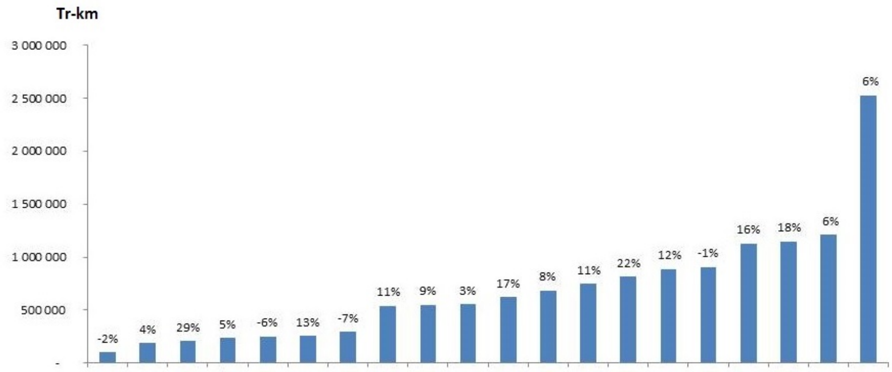

Figure 3: Train-kilometers in 2012, evolution since 2009 in percentage

Output characteristics. A drawback associated with supply-oriented indicators relies in the fact that it does not take into account the number of passengers using the service. Yet, ignoring demand might lead to a misleading conclusion according to which an operator is seen technically efficient although its trains are empty. To tackle this issue and, as it has been done in recent studies in rail transport in Wheat and Smith [2015], we introduced a demand-related output variable ($LOAD$) giving the average load per train. Since our dependent variable is the compensation paid by the region each year, net of the commercial revenues, this variable allows us to control for the demand and not only the supply of public services. We assume that the average load per train has a positive influence on budget and, therefore, should increase cost efficiency.

Inputs prices. Inputs prices on capital, labour and energy are not included in the cost function for the reason that corresponding information was not available. However, as we are analysing the regional directions of a unique firm, one can reasonably assume that they should have access to the same inputs at similar prices. Energy purchases are, for example, made at the corporate level. Other activities, such as maintenance of rolling stocks and traction for the trains are also performed by an entity of the firm operating at a national level and then billed to the local divisions.

Control variables. To control for the heterogeneity of exogenous production constraints, several variables have been introduced. The objective of these variables is to proxy for the complexity of networks and the geographical distribution of the stations, which may alter the operating conditions of the operator and impacts on the operating expenditures.

The first variable *UIC* has been designed to proxy the existence of major rail junctions in the regional networks. In order to construct this variable, we added the number of tracks entering the cities of more than 200 000 inhabitants, multiplied by their UIC coefficient. The UIC coefficient is an international classification for railway lines where the coefficient varies from 1 to 9 and is defined depending on the traffic on the line. The variable was designed such that the higher the value of the variable, the more complex the infrastructure is. We expect this variable to have a negative influence on cost efficiency.

The two other variables *GL* and *GS* intend to capture how the network of stations is designed. *GL* is the number of stations divided by the length of the rail network in each region. Our intuition is that a denser network should increase service complexity and decrease commercial speed thus having a negative impact on technical efficiency. *GS* is the number of station divided by the surface area of the region. We consider this variable to be a proxy for the density of urban territories and, as for *GL*, it is expected to have a negative effect on efficiency.

At last, we introduced a variable giving the average number of stops ($ASTOP$) on a route in the region. As for the variable *GL* and *GS*, we expect that an increase of the average number of stops has a negative impact on technical efficiency since it will be associated with more station charges and a higher energy consumption due to more frequent accelerations[15].

The descriptive statistics of the variables used for estimating the cost frontier can be found in table 1.
Our cost function can be rewritten as (Model 1) :

$$\ln C_{it} = \beta_0 + \beta_1 \ \ln TRKM_{it} + \beta_2 \ \ln LOAD_{it} + \beta_3 \ \ln ASTOP_{it} + \beta_4 \ \ln UIC_{it} + \beta_5 \ \ln GL_{it} + \beta_6 \ \ln GS_{it} + \epsilon_{it} \qquad (3)$$

[15]It has been pointed out to us by experts that the accelerations are a non-negligible source of energy consumptions. In some cases, it justifies a specific formation for the drivers to reduce the operating expenditures.

Table 1: Descriptive statistics

Variables	Description	Average	Median	Min	Max	Std. dev.
BUDTER	Compensation (M €) paid to the operator	131.2	121.5	42	417	78.7
TRKM	Train-km per year	8 534 445	7 817 962	2 803 419	28 300 000	5 128 461
LOAD	Average load per train-km	70.17	68.91	27.73	120.73	19.79
ASTOP	Average number of stops per route	8.10	8.89	6.81	11.57	1.34
UIC	Complexity of the network around the large cities	34.80	27.85	1	106	31.29
GS	Number of station divided by the surface area	0.59	0.42	0.30	1.95	0.44
GL	Number of station divided by the length of the network	0.12	0.11	0.06	0.25	0.04

where $\epsilon_{it} = V_{it} - U_{it}$. V_{it} are assumed to be *i.i.d.* $N(0, \sigma_V^2)$ random errors, independently distributed of U_{it}. It captures the effects of measurement errors, statistical noise and random exogenous chocks. U_{it} capture the technical inefficiency of the regional operator and are assumed to be independently distributed as truncated normal distribution. This decomposition in two terms was defined by Aigner et al. [1977] and Meeusen and Van Den Broeck [1977].

A first methodology would consist in estimating the parameters of the stochastic frontier and the efficiency scores of each firm (*i.e.* the distance to the frontier) as a first step. In a second step, these results would be regressed over the variables explaining the inefficiency of operators using, for instance, an OLS regression. This two stages methodology has been previously used in empirical studies in the public urban transport sector to estimate the inefficiency of operators (*e.g.* Jorgensen et al. [1997]). However, as pointed out by Dalen and Gómez-Lobo [2003] for example, this methodology exhibits an incoherence as the efficiency score are assumed to be independently and identically distributed in the first stage of the regression whereas, in the second stage, those score are assumed to be dependant to firm specific variables, hence they cannot be *i.i.d*

For that reason, we rely on the model developed by Battese and Coelli [1995] where both the parameters of the cost frontier and the impact of firm specific variables over the efficiency score are estimated simultaneously. In this model, the technical efficiency term U_{it} has a truncated normal distribution $N(M_{it}, \sigma_U^2)$ such that $M_{it} = Z_{it}\delta$. Z_{it} is a vector of variables that may have an impact on the efficiency of firms and δ the vector of parameters to be estimated. V_{it} are assumed to have an *i.i.d* normal distribution $N(0, \sigma_v^2)$ and distributed independently to the technical efficiency terms U_{it}. The vector of parameters δ and β are estimated using a maximum likelihood method as well as the associated parameters $\sigma^2 = \sigma_V^2 + \sigma_U^2$ et $\gamma = \sigma_U^2/\sigma^2$. The parameter γ which is included between 0 and 1 gives the influence of technical efficiency on the overall variance of ϵ_i. The closer γ is to one, the bigger the effect of U_{it} is.

Modelling cost inefficiency. In order to test our theoretical predictions, four variables, namely *RATIO, REMU, LEFT* and *TWO* have been included.

RATIO represents the ratio of controllable costs over the overall costs defined at the beginning of the contracts. In other words, this variable represents the share of expenditure subject to a fix flat rate over the overall expenditure that is billed by the operator on a yearly basis. As it has been pointed out earlier, we use this variable as a proxy of the bargaining power of the operator. According to our first proposition, we expect that the higher the variable, the lower the relative technical efficiency.

REMU is obtained by multiplying the variable *RATIO* by the percentage of remuneration on controllable costs defined *ex ante* in the contract. This variable therefore gives the percentage of remuneration awarded to the operator over the overall costs. Consistently with our first prediction, we expect this variable to have a negative effect on efficiency.

LEFT represents the remaining years in the contract over the total length of the contract. According to our proposition 2, the inefficiency is expected to decrease during the contract so the sign of the variable should be negative.

TWO is a dummy variable which is equal to 1 if we are in the two remaining years of the contract and zero otherwise. We introduced this variable to capture the existence of a ratchet effect at the end of the contract (*i.e.* whether the operator deteriorate its performance at the end of the contract, before it enters the negotiation for a new contract with the region).

The corresponding descriptive statistics can be found in table 2.

Table 2: Descriptive statistics of variables on the contracts

Variables	Description	Average	Median	Min	Max	Std. dev.
RATIO	Percentage of controllable costs	76.27%	76.00%	67.10%	85.16%	5.29%
REMU	Percentage of remuneration on the overall costs	1.73%	1.70%	0.65%	2.81%	0.39%
LEFT	years left on the contract divided by the total duration of the contract	49.85%	50%	0%	100%	21.97%
TWO	Dummy variable = 1 if two years or less are remaining	0.25	0	0	1	0.44

As stated earlier, we rely on the methodology developed by Battese and Coelli [1995]: V_{it} is a stochastic term with and *i.i.d.* distribution $N(0, \sigma_V^2)$,independent from Uit. U_{it} is a random variable associated to the efficiency and we assumed its distribution to follow a truncated normal form $N(\delta Z, \sigma_V^2)$ such that:

$$Uit = \delta_1 Z_{1it} + \delta_2 Z_{2it} + W_{it}$$

where W_{it} is a random variable with a truncated normal distribution of zero expectation and variance σ_U^2. Thus, rewriting equation (3):

$$\ln C_{it} = \beta_0 + \beta_1 \ln TRKM_{it} + \beta_2 \ln LOAD_{it} + \beta_3 \ln ASTOP_{it} + \beta_4 \ln UIC_{it} + \beta_5 \ln GL_{it} + \beta_6 \ln GS_{it} + V_{it} - U_{it} \quad (4)$$

Three models have been estimated to test predictions 1 and 2. Model 2 can be described as follows :

$$U_{it} = \delta_1 RATIO_{it} + \delta_2 LEFT_{it} + W_{it} \quad (5)$$

Model 3:

$$U_{it} = \delta_1 REMU_{it} + \delta_2 LEFT_{it} + W_{it} \quad (6)$$

Model 4:

$$U_{it} = \delta_1 REMU_{it} + \delta_2 TWO_{it} + W_{it} \quad (7)$$

4.2 Empirical results

We estimate the cost function shown in equation (4) with the specifications (5), (6) and (7) using the maximum likelihood. An usual specification test has been realised to check the robustness of the estimations. This test compares the constrained OLS model where $\gamma = \sigma_u^2 = 0$ with the models we have estimated. The test statistics is $LR = -2[\ln L_0 - \ln L_1]$ where L_0 is the log-likelihood of the constrained model and L_1 of the unconstrained model. As indicated in table 3, we can reject H_0 and, therefore, conclude on the presence of inefficiency in the models we have estimated.

Table 3: LR-Test results

$H_0 : \gamma = \sigma_u^2 = 0$

	Log-likelihood	LR-Stat	$\Pr(> \chi^2)$
Model 1	71.83	102.24	$1.31 * 10^{-13}$***
Model 2	71.83	78.10	$2.48 * 10^{-3}$**
Model 3	71.83	76.09	0.017*
Model 4	71.83	77.81	$3.29 * 10^{-3}$**

Significance: *$p \prec 0.10$; **$p \prec 0.05$; ***$p \prec 0.01$

Our first empirical result indicates that there is significant efficiency variations from one region to another (see figure 4). When normalizing the best score such that, each year, the most efficient region has a score equal to 1, we can estimate that the average total cost is 394 M € per year higher than it could be. This amount represents 15% of the annual contributions paid by the regions over the time period we consider (2009-2012)[16]. This first empirical result helps illustrate the magnitude of efficiency deviations in our database. What our estimates reveal is that, despite the fact that regional transport services are operated by divisions of a unique firm, it appears that their relative performances differ significantly. To our opinion, this result may contribute to the idea that regional authorities could benefit from the development or regulatory tools based on the measurement of relative efficiency.

The results of the estimations can be found in table 4. Model 1 is the cost frontier as defined by Aigner et al. [1977] where we do not consider a vector Z_{it} of variables that may have an impact on cost efficiency. It is worth noting that, although significant, the coefficient of *TRKM* is lower than 1. This might be due to an endogeneity problem associated with the variable *LOAD*. Further work will be done to tackle this issue.

[16] The compensation payments for regional transport for the 20 regions all together were on average of 2623 M € per year.

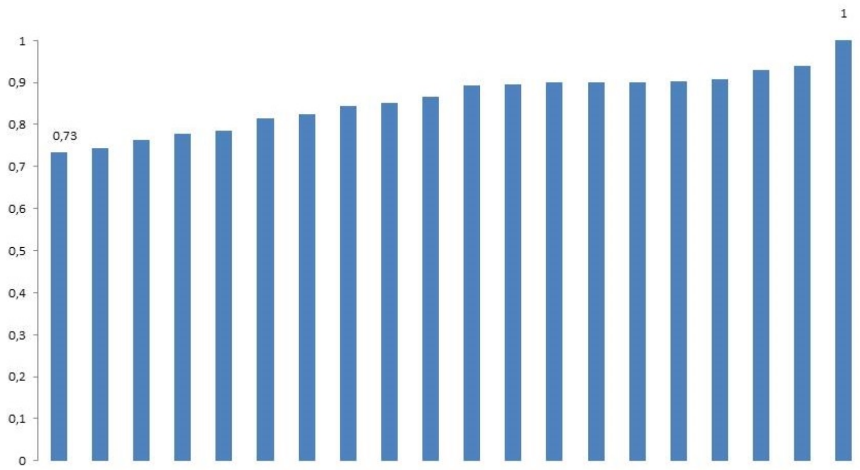

Figure 4: Efficiency scores of model 1, on average over the 4 years

As expected, the coefficient associated with the variable *ASTOP* (*i.e.* number of stops per route) is positive and significant. This result can be partly attributed to the fact that the higher the average number of stops, the higher the station charges (included into the operating costs). Also, with an increase in the average number of stops, train have to accelerate more frequently, thus increasing operating costs. In this regard, we would expect the variable *GL* (*i.e.* number of stations divided by the length of the network) to have a positive impact on operating costs. Yet, the coefficient is significant but negative. A possible interpretation is that a finer-meshed network facilitates actually rolling stocks management, thus decreasing operating costs. At last, consistently with our expectations, we obtain a positive and statistically relationship between the variables *UIC* and *GS* and the operating costs, suggesting that complex transport networks are associated with higher operating costs.
On the economic drivers of inefficiency, our results indicate that both the coefficients of variables *RATIO* and *REMU* are positive and statistically significant (see models 2, 3 and 4) thus corroborating our first proposition. In other words, our results indicate that the higher the share of controllable costs over total costs (and the percentage of remuneration on the total costs given to operators), the higher the deviations from the best practice.

Besides, it appears from our estimations that the coefficient of the variable *LEFT* is negative and statistically significant, consistently with our second proposition: the closer the end of the contract, the lower the technical efficiency.

Table 4: Results

Variables	Model 1	Model 2	Model 3	Model 4
Constant	-10.75***	-10.28 ***	-11.73***	-10.40***
	(0.83)	(0.48)	(0.52)	(0.43)
log(TRKM)	0.66***	0.66***	0.75***	0.66***
	(0.06)	(0.04)	(0.05)	(0.04)
log(LOAD)	0.37***	0.31***	0.36***	0.36***
	(0.08)	(0.06)	(0.06)	(0.05)
log(ASTOP)	0.91***	0.85***	0.70***	0.80***
	(0.17)	(0.11)	(0.12)	(0.07)
log(UIC)	0.05*	0.05***	0.02	0.04***
	(0.02)	(0.01)	(0.01)	(0.01)
log(GL)	-0.61***	-0.54***	-0.58***	-0.64***
	(0.12)	(0.08)	(0.08)	(0.07)
log(GS)	0.21***	0.22***	0.16***	0.27***
	(0.06)	(0.03)	(0.03)	(0.03)
time	-0.13***	-	-	-
	(0.04)			
RATIO	-	0.36***	-	-
		(0.03)		
REMU	-	-	11.55***	14.09***
			(1.39)	(3.26)
LEFT	-	-0.22**	-	-0.26*
		(0.08)	(0.01)	(0.12)
TWO	-	-	0.06*	-
			(0.03)	
$\sigma^2 = \sigma_v^2 + \sigma_u^2$	0.01*	0.01***	0.01***	0.02***
	(0.04)	(0.01)	(0.01)	(0.01)
$\gamma = \sigma_u^2/\sigma^2$	0.84 ***	1 ***	0.97***	1***
	(0.05)	(0.01)	(0.26)	(0.01)
Log likelihood	102.24	78.10	76.09	77.81
Mean efficiency	0.83	0.84	0.81	0.84

Significance : $*p \prec 0.10$; $**p \prec 0.05$; $***p \prec 0.01$

Standard deviation in parenthesis

In the same vein, the coefficient associated with the variable TWO is positive and significant, suggesting that efficiency is on average lower during the last two years of the contract. This finding support our prediction according to which a ratchet effect exists at the end of the contracts, where the operator might decrease its performance when the negotiations over the new contract have begun.

5 Conclusion

In this paper we estimated a cost frontier to measure the technical efficiency of the 20 regional operators in regional railway transport. Our results indicate that there are significant efficiency differences between the regional local operators as the estimated efficiency scores ranges from 0.73 to 1, despite the contracts being operated by a single firm. Overall, according to our results, the cost could be reduced by 15% if all 19 regional operators adopted the best practice of the most efficient one. Part of the heterogeneity of efficiency we observe can be attributed to the network characteristics we identified, such as the spatial distribution of rail stations and the complexity of the rail networks. However, our results also highlight the impact of contractual schemes on efficiency in this sector.

Our results indicate, in particular, that the contractual design does not produce the expected incentives as the share of cost under a revenue cap is found to have a negative impact on technical efficiency. Furthermore, and consistently with our predictions, we found that cost efficiency decreases over the contractual life. According to our predictions, this dynamic effect may result, at least to some extent, from the fact that the market is non contestable in our sector.

A first policy recommendation could be derived from our results. In our view, an increase of the expertise capacity of regional authorities would indeed help to reduce the contractual drawbacks identified in our paper. For that purpose, the transport authorities could benefit from the informational externalities generated by the efficiency benchmarking of their regional operator. To some extent, our paper illustrates that such a regulatory tool could be technically implementable in the sector. This recommendation is in line with the position paper of the Independent Regulators' Group - Rail on competitive tendering for public service contracts suggesting that yardstick competition "*can be seen as a means to introduce some "virtual" competition into industries where market competition is either not viable or not desired.*"

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