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Vertical Separation in Rail Transport : How do Prices Influence Coordination ?*

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Very preliminary version, please do not quote

Abstract

This paper contributes to the debates over the relative performance of governance modes in network industries. The issue of vertical separation and integration in network industries have been extensively studied from several perspectives including competition effect, production cost synergies or coordination costs. The aim of this paper is to use the French rail sector example to shed the light on the crucial and understudied impact of coordination costs. We believe indeed that this approach may help identifying drawbacks arising with separation in the sector and, therefore, providing public policy recommendations to prevent those failures when possible.

We develop a preliminary model explaining why inefficient outcomes may arise in the railway sector when vertically separated firms have to commit ex ante on quantities. Our first results indicate that credible and effective price regulation can overcome the limits of separation on the infrastructure side. On the other hand, if the market is not flexible enough, it may become harder for railway undertakings to sustain an equilibrium with high output as the downstream market is becoming more competitive.

Keywords: Vertical separation, Regulation, Rail transportation.

1 Introduction

In the last two decades, major structural reforms have been implemented in most network industries. Considerable attention have been devoted by economists to the analysis of gas, telecom or electricity industries and, surprisingly, relativity little notice had been paid to railways so far. Yet, driven by the European institutions, the railway transport sector in

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Europe has also gone through both institutional and organizational reforms during the last twenty years. A main objective of those reforms is to broke up the national monopolies in order to open up rail market services to competition. Directive 91/440/EC was the first milestone to this process by introducing a degree of vertical separation in the sector. It required an accounting separation between the management of the essentials facilities (*i.e.* the management of the railway network) and the operation of rail services[1], which were deemed potentially competitive. Since then the railway sector which consisted of vertically integrated monopolies has progressively opened to competition. Directive 91/440/EC allows for different degrees of vertical separation and, as a consequence, different governance modes coexist today in Europe.

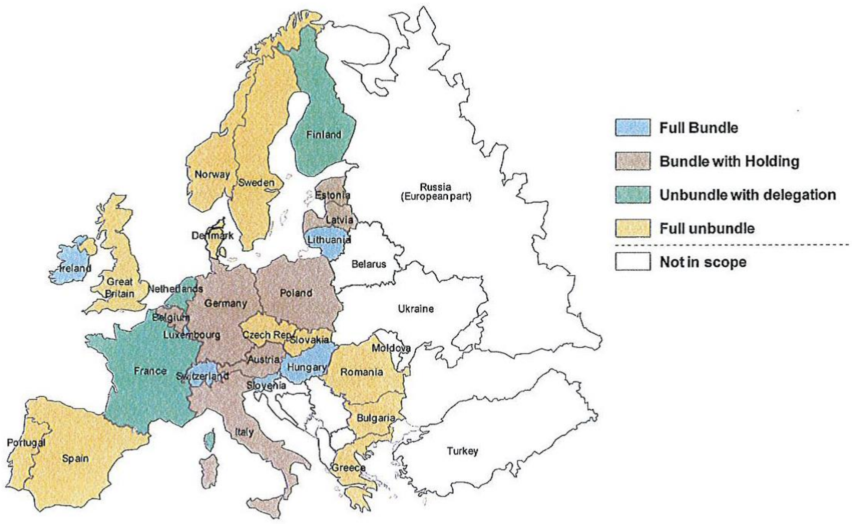

Figure 1: Governance modes for rail transport in Europe (year 2012)

Interestingly, four main modes of organization can be found in Europe, as highlighted in Figure 1[2]:

- *Full unbundle* : full separation between the infrastructure manager (IM) and railway undertakings (Ru);

[1]Directive 91/440/EEC of 29 July 1991 states that "[w]*hereas the future development and efficient operation of the railway system may be made easier if a distinction is made between the provision of transport services and the operation of infrastructure; whereas given this situation, it is necessary for these two activities to be separately managed and have separate accounts; The aim of this Directive is to facilitate the adoption of the Community railways to the needs of the single market and to increase their efficiency*; [...] *by separating the management of railway operation and infrastructure from the provision of railway transport services, separation of accounts being compulsory and organizational or institutional separation being optional.*

[2]Source : Boston Consulting Group (2012), The 2012 European Railway Performance Index.

- *Unbundle with delegation* : separation between the IM and RU, where the IM delegates infrastructure maintenance and operational management to a RU;
- *Unbundle with holding*: separation where a holding company owns the IM and the RU;
- *Full bundle*: a unique firm operates infrastructure management and rail services.

This heterogeneity raises the question of the comparative merits of the different vertical separation degrees characterising rail transport in Europe. Yet, to our knowledge, no strong theoretical and empirical evidences suggest that the overall impact of vertical separation on consumer surplus is positive (or negative) in the sector. As a consequence, there is no clear answer to the optimal structure of the rail transport sector in Europe. A key objective of the paper is to shed light on this debate by focusing on a understudied issue, namely the coordination problems between the upstream (*i.e.* infrastructure access management) and the downstream (*i.e.* rail services activities) markets.

A large body of the literature in industrial organization has tried to analyze the pros and cons of vertical separation in network industries, especially in an industrial economics perspective (*e.g.* Vickers [1995], Sappington [2006]). Sources of relative performances of vertical separation and vertical integration are numerous and difficult to isolate but can be classified into four main dimensions : competition effect, production cost synergies, production cost incentives and transaction costs.

The basic argument is that the main driver of vertical separation relies on the need to improve competition in the downstream market (Sappington [2006]). Indeed, a vertically integrated company has the incentive to exploit its position to protect his competitive advantage against new entrants. It could translate, in particular, into lower infrastructure service quality and/or higher infrastructure access charges for (potential) competitors. A vertically integrated monopoly may, for example, be able to impose excessive delays for the access of inputs on the downstream market. This classic drawback associated with vertically integrated settings is well summarized by Reiffen and Ward [2002]. The authors recall that "*well-established economic principles indicate that a regulated monopolist with an affiliate in an unregulated business may have an incentive to deny the affiliate's competitors access to an 'essential' input, or more generally, degrade the quality of service of the input supplied to the competitors.*" The particular situation of non-price discrimination (*i.e.* "sabotage") by a vertically integrated monopolist has been analysed by a number of papers, since the seminal study by Economides [1998]. Mandy [2000], Beard et al. [2001] or Mandy and Sappington [2007], among others, provide detailed analysis of the potential and the impact of sabotage by a vertically integrated supplier. In the same vein, Sappington and Weisman [2005] analyse the incentives to develop "self-sabotage" whereby a vertically integrated monopolist intentionally raises the upstream costs and/or reduces quality, including for its downstream subsidiary. Empirical evidences of sabotage can be found, for example, in Reiffen et al. [2000] or Reiffen and Ward [2002] within the cellular phone markets in the US.

Following those developments, one could argue that vertical separation should limit the risk of discrimination and foreclosure. By reducing competitors' operating costs and final prices for consumer through the fostering of competition, vertical divestiture should contribute to secure a higher level of consumer welfare.

This argument underscores however a number of important dimensions which have to be considered, in particular in the rail transport market.

Another driving force of vertical integration relies indeed on the technological interdependencies between upstream and downstream markets. Behind academic papers examining that question is the assumption that a vertically integrated structure may entail significant economies of scope due, for example, to the existence of common fixed costs. In the rail transport sector, a first set of studies examines the cost synergies between infrastructure management and trains operations (see, for example, Ivaldi and McCullough [2001], Ivaldi and McCullough [2008], Growitsch and Wetzel [2009] or Mizutani and Uranishi [2013]). Empirical results highlight that vertical disclosure might be associated with higher costs due to the existence of scope economies between rail infrastructure management and train service operations. In that perspective, an integrated mode should be preferred when the potentials for scope economies outweigh the economic losses in terms of competition. This central trade-off have been formally addressed by Crew et al. [2005] in the general case of network industries.

Another well-known advantage of vertical integration relies in the fact that the risk of double marginalization is limited. A double marginalization problem arises in a situation where an infrastructure manager does not internalize the vertical externalities it generates on downstream operators, leading to higher access charges and final prices.

A fourth determinant of vertical integration is the impact on incentives for cost reductions. In a vertical separation setting, both firms will become more specialized in their respective fields, which could result in better incentives toward performance. Besides, large integrated firms may experience significant problems in implementing internal incentive schemes to reduce production costs (due to the fact that, in such settings, aligning the incentives of the upstream and downstream firms could be subject of great difficulties). Moreover, by increasing information asymmetry and corresponding incentives to raise artificially access charges, vertical integration complicates the design of an optimal regulatory policy (Vickers [1995]). Heavy forms of regulation are, *de facto*, required to secure substantial surplus for consumers.

At last, following developments in transaction costs economics (Williamson [1985]) and incomplete contract theory (Grossman and Hart [1986]), it is argued that coordination costs are a core determinant of vertical integration in network industries. In this account, a basic proposition is that a main driver is the need to secure specific investments in a context of environmental uncertainty. Poor efficiency may arise from a misalignment of the governance structure. Using the transaction costs theory, as suggested by Pittman [2005], Mizutani and Uranishi [2013] test the relevance of vertical separation depending on the network's usage density, used a a proxy for asset specificity. They argue, in particular, that the governance costs should increase rapidly with an increase in network usage as its operation becomes more and more complex. Yet, it is stated that the interactions between operating trains and infrastructure management become more complex with vertical separation. Hence, their proposition is that governance costs should increase dramatically should the industry be unbundled.

Mizutani and Uranishi [2013] were able to test this relation empirically. Results indicate that vertical separation is associated to an overall decrease in costs. Nonetheless, when the usage of the network is very important, separation becomes more costly. Those results corroborate previous findings by EVES-Rail (2012).

We believe those two results to highlight the key role of coordination costs in the railway industry. To tackle this issue, we focus on the French rail transport framework and we develop a preliminary model to examine the nature and the impact of coordination problems between IM and RUs. Our preliminary results indicate that vertical separation may lead to inefficient outcomes, unless the regulator is able to implement a credible regulation of mark-ups.

The paper is organised as follows. Section 2 provides an overview of the french capacity allocation process. Section 3 presents our preliminary model and section 4 offers concluding remarks.

2 Coordination costs in the railway industry : the French case

To illustrate possible coordination issues, we look into the capacity allocation process in France. *Ex ante* coordination is needed between the railway operators and the infrastructure manager so that the capacity made available matches the capacity needed. We focus on this process because both environmental uncertainty and opportunistic behavior can arise. We analyze the three stages of this process mainly based on the French case. The French process for allocating capacity is depicted in Figure 2 and illustrates the length of the overall process.

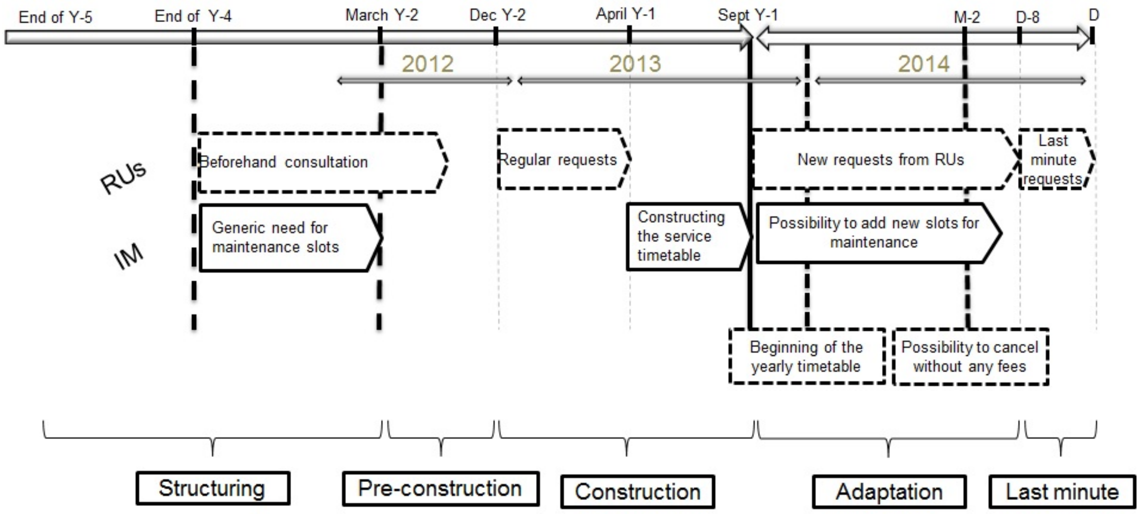

Figure 2: The French capacity allocation process

The first stage consists in structuring the timetable. In the French case, this takes the form of a consultation phase beforehand starting 4 years before the circulation date. The objective is to find the long term needs of the operators, potentially reducing the information asymmetry between the two. During this stage, there is no binding agreements between the infrastructure managers or the operators. Yet there might be forms of commitment made by both sides. On the infrastructure side, the monopoly will have to define its general maintenance policy. The trade-off ranges from concentrating maintenance on one slot, that is blocking a segment for a longer time but only having to deploy the maintenance team once which would be less costly, to doing its maintenance at night, where it is more expensive but should have less impact on the maximum number of trains running. According to the signals sent by the undertakings, maintenance might also be focused on one track portion rather than the other. The overall anticipated increase in demand at this point might also have an impact on the pricing scheme for track access as more trains running will help absorb the fixed costs of the network. Regarding the operators the 4 year time-span may correspond to its decision to invest in new rolling stocks or other productive inputs.

The second stage which is constructing the service timetable after the formal requests are made. The length of this second stage has been bounded by directive 2001/14/EC: there should be a working timetable once a year and the deadline for capacity request should be at most 12 months before the beginning of the new timetable[3]. This means that some requests for capacity can still be made up to two years before the train effectively runs. Especially for the freight transport services this time span means that there is environmental uncertainty as it is very difficult for a railway operator to forecast its demand for transport services in advance. At this point there are many incentives for the undertakings to ask for more than what they need, especially in the freight market. First of all it might be because they are anticipating some negative responses. Secondly they also have to anticipate for hazard during the service. This hazard might be due to technical conditions, or may be entailed by the infrastructure manager changing its maintenance slots. Thirdly it might be a strategic behavior to preempt capacity from the other operators. For instance in France the former incumbent for freight railway services was condemned for such practices in 2012 by the French competition Authority[4]. Table 1[5] shows the ratio between capacity used over the capacity that had been booked. It is important to note that the figures themselves were not considered as evidence of anti-competitive overbooking acknowledging the fact that operators need spare capacity to face all kinds of hazards. In this case the capacity overbooked represented around 20% of the capacity allocated.

We refer to the third and last stage as adaptation. During this stage there is trade-off

[3]See annex III of the directive 2001/14/EC on the schedule for the allocation process

[4]See Decision by the French Competition Authority 12-D-25 of December, 18^{th} 2012 relating to practices used in the freight railway transport sector

[5]Source: French Competition Authority, Decision 12-D-25, paragraph 131

Year	2006	2007	2008	2009	2010	2011
Capacity used	78,27%	78,19%	75,80%	82,06%	77,38%	74,14%

Table 1: Ratio of capacity used over capacity demanded for Fret SNCF

to be made between allocation certainty and flexibility. On the one hand the directive states that the infrastructure manager should be able to "*levy an appropriate charge for capacity that is allocated but not used*[6]". On the other hand the process for allocating capacities should "*have regard to the business requirements of both applicants* (*i.e.* the railway undertakings) *and the infrastructure manager*[7]". It does seem that flexibility is amongst the business requirements of a railway operator, especially in the freight railway sector as it is facing competition from other modes of transport. The French infrastructure manager has made this arbitrage by deciding that reservation fees will be reimbursed if the capacity is given back 2 months prior to the date the train is scheduled to run.

Coordinating the need for capacity and its demand is both a long and uncertain process. It is worth noting that the trade-off between lowering the overall cost for maintaining the network and making capacity available will become more relevant as the use of the network is increasing. This is in line with the result of Mizutani and Uranishi (2012). Issues may also arise *ex post* that is on the date the train is scheduled to run with real-time coordination between operators and the organism in charge of traffic management. In the absence of a performance scheme where both network users and its manager internalize the negative effects of disrupting the timetable, these costs might grow. Yet this matter relays more to market opening rather than vertical separation itself. Therefore our read on the situation is that with vertical separation, the coordination costs will arise because of the need for flexibility along the allocation process while commitments in specific inputs are made.

3 The model

3.1 Description of the model

We consider the two players in the railway industry, that is the infrastructure manager (IM) on the upstream market in charge of producing and allocating the railway paths and the railway undertakings (RUs). The production cost of the IM depends on the main-

[6]See article 36 of directive 2012/34/EU.
[7]See recital 52 of directive 2012/34/EU.

tenance policy. If more capacity has to be made available then this extra capacity will be costly. For two level of quantities produced q_H and q_L with $q_H > q_L$ we denote k the average cost the IM has to commit to in order to increase its production. (The cost of production will increase by $k(q_H - q_L)$). In the downstream market, railway undertakings[8] are competing to sell railway transport, where each unit of railway transport requires one path. The average marginal cost an operator has to commit to in order to increase its production from q_L to q_H is denoted c.

We focus on the downfalls of separation arising from the lack of coordination between both players creating a possible tension between the quantities served by the IM and the effective use of capacity by the RUs. These tensions rise due to uncertainty in the final demand and the opportunistic behavior arising from flexibility on both sides. To take into account the uncertainty of the demand for transport services, we assume there are two states of nature denoted L and H where H corresponds to the state of nature with a positive shock in demand compared to L which is the standard demand for rail transport services. The prior distribution for each state is common knowledge and is defined by $Pr(H) = \pi$ and $Pr(L) = (1 - \pi)$.

For a given state of nature the optimization program will lead the RUs to an equilibrium price for rail transport services and a quantity. We denote Mu_H (respectively Mu_L) the mark-up the downstream firms are able to levy above the cost of production when demand will be high. q_H and q_L are the quantities served associated to those prices[9]. We make the assumption that $Mu_H > Mu_L$ and $q_H > q_L$. When the demand is high, the quantities served will increase despite an increase in prices.

The network manager can either choose to produce q_H or q_L. We assume that the access charges pricing scheme allows to recover marginal costs of production, and that the IM may levy a mark-up if it had anticipated a high demand, and the demand is indeed high. This is a consequence of the right to price above marginal cost in order to recover its full cost as stated in directive 2001/14/EC[10]. In our model the IM is allowed to levy a

[8] Formally the infrastructure manager will be interacting with one representative railway undertaking.

[9] Note that using Cournot competition to model the interaction between the downstream firms, we would have that $Mu = \frac{(QP'(Q))}{n}$ where P(Q) is the inverse demand function and P'(Q) its derivative. Therefore the shift in mark-up will depend both on the shift in elasticity and the overall increase in demand.

[10] Article 8.1 of directive 2001/14/EC: In order to obtain full recovery of the costs incurred by the infrastructure manager a Member State may, if the market can bear this, levy mark-ups on the basis of efficient, transparent and non-discriminatory principles, while guaranteeing optimum competitiveness in

mark-up if the market can bear it, that is if the demand is high but also if the IM had anticipated a high demand. We denote the mark-up of the IM Mu^{IM} and assume it is fixed exogenously implying that a regulator has to give its assent to any mark-ups from the IM[11].

To highlight the potential coordination issues, we model the outcome of the market using a normal form game. We assume that both agents have to commit to a quantity produced and to a maximum price. Therefore both the infrastructure manager and the railway undertaking have a set of action $A = L; H$. Once they observe demand, they have limited possibilities to adjust their offer. They can only sell less than what they had produced and may only lower their price. Given that we need the supply of capacity to equate its demand, we need the following rules on the coordination between the two players, namely the infrastructure manager and the railway undertaking:

1. If a firm played H and the other firm plays L, then it has to sell less, that is selling q_L instead of q_H
2. If a firm played L and the state of nature is H, it has to sell at a lower price, that is levying Mu_L instead of Mu_H (or 0 instead of Mu_{IM} in case it is the IM)

We enforce those two rules in order to have market clearing. The payoffs are represented in Table 2.

IM \ RU	H	L
H	IM: $\pi(q_H Mu^{IM}) - (1-\pi)(q_H - q_L)k$; RU: $\pi q_H(Mu_H - Mu^{IM})$ $+(1-\pi)[(q_L Mu_L - (q_H - q_L)c]$	IM: $\pi q_L Mu^{IM} - (q_H - q_L)k$; RU: $q_L[Mu_L - \pi Mu^{IM}]$
L	IM: 0 ; RU: $\pi q_L Mu_H + (1-\pi) q_L Mu_L - (q_H - q_L)c$	IM: 0 ; RU: $q_L Mu_L$

Table 2: Payoffs matrix

3.2 Outcome of the game

Since there is no administrative control with vertical separation we could have two uncoordinated equilibria. In both those outcomes, either the network manager or the operator are left with unsold goods. This leads to inefficiency in the railway sector. We focus our

particular of international rail freight.

[11] By assuming that Mu^{IM} has no effects on q_H we neglect part of the downfalls of double marginalization.

analysis on the conditions for those two inefficient outcomes to occur, and in particular how the mark-ups levied affect the coordination first for the infrastructure manager, then for the operators.

If the outcome of the game is HL, that is the IM produces anticipates a higher demand than the RU, then the cost of spoilage would be $(q_L - q_H)k$ which has to be balanced with the potential mark-up in case the demand is high. In order for HL not to be a Nash equilibrium, we need that L be the best reply to L. Thus the condition is that $Mu^{IM} < \frac{1}{\pi}\frac{q_H - q_L}{q_L}k$. On the other hand, if we want LH not to be a Nash equilibrium we need to make sure that the potential mark-up is greater than the potential costs. The condition is that $Mu^{IM} > \frac{(1-\pi)}{\pi}\frac{q_H - q_L}{q_H}k$.

As we can see, this leads to an upper and lower bound[12] for the mark-up of the IM if we want to avoid uncoordinated equilibria. The upper bound represents the fact that if the IM is able to levy too-high a mark-up when the conditions are met, then there will be more incentive to serve higher quantities, despite the low odds of the demand actually being high. On the other hand the lower bound is the necessary counter part so that the IM assumes the risk of a low demand and leading to spare capacity.

Result 1 : Should $Mu^{IM} \in [\frac{(1-\pi)}{\pi}\frac{q_H - q_L}{q_H}k; \frac{1}{\pi}\frac{q_H - q_L}{q_L}k]$ then no uncoordinated outcome can be a Nash equilibrium.

Result 1 states that we can limit the behaviors of the IM leading to inefficient outcomes by bounding its mark-up. Given that the pricing scheme of the infrastructure manager can be reviewed by an independent regulator in the European Union, it should be possible to bound the mark-up. The lower bound gives us the amount of incentive the IM needs in order to avoid producing low quantities. If we rule out the possibility to have access charges above marginal prices when the market can bear it, then the network manager will never risk producing a high amount of capacity. The upper bound is needed so that the infrastructure manager does not always anticipate high quantities. If the allowed mark-up is too high, the regulated monopoly will be over-producing.

In our setting, the mark-up compensates for the absence of outside option for spare capacity. If there was an outside option for at least a part of spare capacity, this would shift

[12]Given that $q_h > q_L$ then we always have that $\frac{(1-\pi)}{\pi}\frac{q_H - q_L}{q_H}k < \frac{1}{\pi}\frac{q_H - q_L}{q_L}k$

the interval downwards. Should competition in the downstream market bring such an outside option, then the IM would have an incentive to produce higher quantities, at the risk of being an overproducing monopoly. If we consider that the IM can only have price above its marginal cost in order to recover its full cost, as stated in directive 2001/14/EC, then an extra condition for this result to hold is that the difference between full cost and marginal cost be within the bounds of the interval we have defined.

With the full separation, the pricing scheme can be an important tool for the regulator to mitigate the risk of an uncoordinated outcome to occur as well as inducing the capacity made on the network. With a holding structure, those incentives will be dulled by the IM internalizing part of the downstream market's overall profit. This may raise as well the issue of cross-subsidies, making it less legitimate for the IM to levy mark-ups.

We now check the condition under which the RUs favor a coordinated equilibrium as well:

- H is the best reply to H if $(Mu_H - MuL) > \frac{q_H - q_L}{q_L}[\frac{(1-\pi)]}{\pi}c + (Mu^{GI} - Mu_H)]$.
- L is the best reply to L if $(Mu_H - MuL) < \frac{1}{\pi}\frac{q_H - q_L}{q_L}c$.

These two thresholds can be expressed using the increase in mark-up. Similarly to the IM, we find an upper and lower bound in order to avoid an uncoordinated outcome. For those two conditions to be met at the same time we need that $Mu^{GI} - Mu_H < c$.

Result 2 : Should $(Mu_H - MuL) \in [\frac{q_H - q_L}{q_L}[\frac{(1-\pi)]}{\pi}c + (Mu^{GI} - Mu_H)]; \frac{1}{\pi}\frac{q_H - q_L}{q_L}c]$ then no uncoordinated outcome can be a Nash equilibrium.

Contrary to the IM's case, the increase mark-ups is an outcome of the market and can not be regulated when there is downstream competition. The upper bound of the interval directly refers to the shift in elasticity of the firm and its ability to capture it. As competition increases in the downstream market, the difference in mark-ups should tend to zero and the upper bound of our interval has less chance of being met. Conversely with little competition on the downstream market, the odds of having the downstream firms favoring the possible increase in its revenue to the sure increase in cost are more important even with a low probability of demand being high.

The lower bound of our interval is more problematic as it sheds to light a possible cause for an inefficient outcome. This threshold states that the increase in mark-up should cover the uncertain increase in costs due to over-producing plus the mark-up of the infrastructure manager. As competition is increasing, then the mark-ups a downstream firm are able to levy will not be high enough to compensate for this risk. Therefore the more competition, the more the downstream firms tend to play the low quantity outcome. Rewriting the threshold as $Mu^{GI} < \frac{q_H Mu_H - q_L MuL}{q_H - q_L} - \frac{(1-\pi)}{\pi}c$ we identify the condition in our model under which the downstream market can bear any deviation from marginal cost pricing. The mark-up of the infrastructure manager becomes harder to bear for the railway undertakings as their market power decreases and as competition is increasing it becomes more prejudicial to the quantities served on the market. It also stresses the importance of the need for flexibility in the downstream market. In our model it is the absence of outside option for the railway undertakings that leads to too little production. ($(q_H - q_L)c$ which is the cost of committing to more input and is a sunk cost for a railway operator). The absence of outside option is a fairly strong assumption.

3.3 Discussion

Our results lead to conditions under which the effects of vertical separation on coordination can be mitigated. We must stress that this is only a partial analysis of the vertical integration problem. As we have stated earlier there are several dimensions to be taken into account when analyzing the vertical organization. In our model we elude the potential losses due to economies of scope with vertical separation. We also assume a dichotomous repartition of coordination costs where only a separated form would face such issues. Yet similar issues could arise in a large integrated firm but this question is left for further research.

We also limit the competition effect to a decrease in mark-ups on the downstream markets. Especially in our model, coordination issues are linked to the absence of outside option once the firm has committed to a certain level of production. We could argue that as the market becomes more competitive the outside option is increasing for the infrastructure manager who could assign the capacity to a different railway undertakings. Regarding the outside option of the railway operator it should be able to redeploy its productive factors from one railway line to another inside a same country. Increasing interoperability across networks could also limit the level of sunk costs an operator has to bear if productive factors can be used in an other country.

To develop further this model, we would need to take into account the asymmetric information between the upstream and downstream markets as well as within the downstream firms. The operators should have a better understanding of the demand and our model does not take into account the strategic behaviors this could entail. We also do not capture the disincentive to share information with the infrastructure manager if it means sharing it with the competing operators.

4 Conclusion

Our objective in the paper was to contribute to the debate over the relevance of vertical separation/integration in network industries. Although this issue has generated considerable developments in gas, electricity or telecommunication industries, few studies have been devoted to the railway sector. Furthermore, most of the existing studies on rail transport sector do not address the impact of governance costs on the optimal organisation scheme. A main objective of this paper is to fill this gap by developing a model focusing on coordination problems arising between the upstream (*i.e.* infrastructure access management) and the downstream (*i.e.* rail services activities) markets.

Our paper highlights that a key step of the coordination between the infrastructure manager and the operators is the capacity allocation process. The railway sector is facing uncertainty on the final demand due to the overall length of this process. Therefore the attribution process was made very flexible, both sides not having to commit to one another. Yet the firms have to commit themselves to the total input they will be needing. This could lead to uncoordinated market outcomes, thus a loss of performance for the railway sector. With vertical integration such outcomes should not arise given the administrative control.

In our model we analyze why such outcomes would take place, using the mark-ups levied upstream and downstream. When the upstream mark-ups are controlled by a regulation authority, we find the conditions to constrain the infrastructure manager to a coordinated outcome. Therefore with an effective price regulation the network manager will not choose outcomes that are inefficient for the railway sector. Regarding the downstream market, the conditions for the railway undertakings to favor a coordinated equilibrium are not so easily met. Especially as the market power of downstream firms decreases the lower threshold necessary to have a high output equilibrium is more problematic. There are two implications to the lower threshold we have identified. Firstly we obtain the condition for the market to bear any deviation from marginal cost pricing for the access charges which are directly related to the market power of downstream firms. Secondly an increase in the outside option of downstream firms for their spare inputs would increase their incentive to deliver high outputs, even with downstream competition. We believe this outside option could be a higher interoperability between European networks making it possible to reallocate productive inputs from one country to another.

Although this study is only a first step in the analysis of the impact of coordination costs on the vertical integration/separation performance in rail transport, preliminary public policy recommendations can be derived from our results. Indeed, our findings highlight the key role of a regulation authority on vertical separation efficiency. More precisely, an implication of the model is that the regulation of mark-ups on the upstream segment is likely to mitigate the coordination problems associated with vertical separation.

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