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Creating a National Champion: International Competition and Unbundling in Rail Transportation

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Creating a National Champion: International Competition and Unbundling in Rail Transportation☆

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Abstract

This article investigates the incentives to unbundle operations and infrastructure in the railway industry in a two-country model with international network effects from the viewpoint of national governments. The analysis shows that the decision to unbundle institutionally or organizationally with separated accounts depends crucially on the importance of cross-border transportation. For a sufficiently high importance of cross-border transportation, national governments choose accounting separation. However, national governments are stuck in a Prisoners' dilemma and would be better off coordinating on a separated industry structure. This result justifies major policy initiatives by the European Union but explains also actions of national governments in implementing these initiatives.

Keywords: bundling, vertical integration, international competition, railway, regulation, cross-border transport

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1. Introduction

Transportation facilities are an essential part of a country's infrastructure. Efficient traveling and transportation of production and consumption goods are essential requirements for efficient trading within and across countries. Among the different transportation modes railways are one of the most important, e.g., in Europe exist 212,000 km of railways compared to only 68,000 km of motorways. Railways offer not only a comprehensive network to transport passengers and freight, but have also more than 700,000 employees in Europe (EC, 2012). Historically, railways in Europe were operated by state-owned monopolists managing the infrastructure and the transportation facilities. Even though most of the European countries privatized their railway operations, the markets remained relatively closed with a low degree of competition. In recent years, the European Commission started to promote railways and increased liberalization efforts to open up national markets (EC, 2001). Recently, the European Commission published a White Paper (EC, 2011) on the road map to a single European transportation area in which the commission highlights the key role of railways in achieving a resource-friendly transportation area. In order to reach efficient and liberalized markets, the issue of (un)bundling the infrastructure and operations is hotly discussed. This article contributes to this discussion by focusing on the role of national governments and shows that national governments may have incentives to keep the home market operator integrated with the infrastructure owner even if no efficiency gains are present. The main argument is that governments want to create national champions who are strong for competition abroad.

It is undisputed that unbundling is necessary to rule out cross-subsidies from access-charges and public funds to the operational activities. However, it is often argued that regulating the access charges and separating the accounts into two firms is sufficient, and that the ownership plays only a minor role. In the process of liberalizing the European market, national governments play a key role. Governments were free to choose between the models of institutional separation (IS) and organizational separation with separated accounts (AS) for their national railway systems. Some countries opted for IS (e.g., UK and the Netherlands) while others chose AS (e.g., Germany and Italy) leaving the infrastructure and operations in the same hands.[1] In both models the access charges for the infrastructure are regulated by national regulators. Unfortunately, it is unclear which factors drive the decisions of the national governments.

This article analyzes the topic of unbundling in the railway sector by describing the industry in a stylized two-country model with international network effects. The equilibrium analysis focuses on national governments who choose between accounting and institutional separation. Because access prices are regulated, strategic price mechanisms play no role in the decision. Instead, I analyze the role of non-price related factors. Non-price discrimination can be done by providing poor quality, setting tech-

[1] See IBM (2011) and Online Appendix B for an overview of the different organization forms across European countries.

nical and safety requirements, or the ability to allocate time schedules. I assume a perfectly regulated environment with respect to prices. However, an integrated firm with separate accounts holds all unregulated residual control rights which it can use to discriminate competitors (see e.g. Economides, 1998; Sand, 2004, for a more general discussion of non-price discrimination). In contrast, an institutionally separated infrastructure provider has no incentives to discriminate between the competitors. I focus on long-distance passenger traffic and freight transportation because I am interested in the cross-country effects of bundling infrastructure with operations. The crucial factor of my analysis is that consumers value the network density of an operator, i.e., the number of routes and their travel frequency, in the home country and abroad. A denser network offers more possibilities to travel to a specific destination and shortens the waiting time for connection trains.

The analysis shows that the decision of governments about the unbundling alternatives depends on their objective function. A government who is only interested in the welfare generated in the home country is always better off with IS. However, a government valuing to some degree the profits of the incumbent abroad chooses AS if the international network effects are sufficiently large. An unilateral integration with separate accounts gives the integrated firm a strategic advantage in offering network densities to consumers at home and abroad. The resulting higher profit compensates for the loss in consumer surplus. The government accepts less competition in order to create a national champion who is strong for competition abroad. Unfortunately, both governments have the same incentives, choose AS in equilibrium and are worse off compared to a situation in which both separate institutionally. This result shows the need for coordination mechanisms on the level of the European Union. Accounting separation may not be enough, it helps national governments to slow down efforts in opening their national market in the transition period. Obviously, these incentives to restrict competition are only present with incumbents that are internationally active. A result that explains the different organization structures among European countries.

The general discussion about unbundling is based on two competing arguments. The opponents argue that transaction costs[2] between the operator and infrastructure owner are lower in an integrated firm, whereas the proponents argue that vertical integration hinders competition which leads to inefficiencies in the sector. The hybrid model of accounting separation should serve both arguments. The advantages should be reached without the disadvantages. It is highly controversial if such an outcome is possible, because ownership allows the access to all residual control rights by which competitors can be discriminated. I do not consider the transaction cost argument in my analysis. The only mechanism at work is a barrier to competition. Even though I take only a socially negative effect into account, I find that national governments have incentives to unilaterally integrate their home market activities with separate

[2]Transaction costs broadly defined describe any kind of costs that are related to a transaction between the two entities.

accounts.

This article is directly related to the small literature on the optimal structure in the railway industry as analyzed by Friebel et al. (2008). Different to my article they analyze the role of economies of scale in combination with strategic effects via a combined price-setting mechanism for the organization decision from the railway firm's perspective. My article has also similarities to the question of airline and airport integration or collusion as analyzed by Barbot (2009) who also uses a combined price-setting analysis in her model.

The empirical analysis of vertical integration is in general associated with difficulties because the relevant information are scarce and comparable accounting data is usually not available. Therefore, academics performed efficiency analysis based on comparable output measures in order to evaluate the organization form of operators. The empirical findings are rather mixed. Merkert et al. (2012) analyze European countries and find that vertical separation raises transaction costs (modestly). Similarly, Bitzan (2003) and Growitsch and Wetzel (2009) find that separating operations and infrastructure increases the costs. Laabsch and Sanner (2012) investigate the influence of bundling on the attractiveness of railways compared to other transportation modes for nine European countries. The authors show that full institutional separation results in a significant decline in the modal share; pointing to efficiency gains of integrated operators.

In contrast, Cantos et al. (2010) provide evidence that efficiency increased with ownership separation in Europe. Friebel et al. (2010) observe positive effects of reforms in the sector, but find similar to Driessen et al. (2006) no consistent results with respect to different types of separation. Finally, Ivaldi and Mc Cullough (2001) find no cost complementary among operation and infrastructure for US freight railroads.

My analysis has familiarities with models of strategic trade competition. Brander and Spencer (1985) show that export subsidies help to enhance the competitive position of domestic firms in a third market. Finally, one can interpret network density as the quality of an operator. Therefore, the model is related to the literature on non-price discrimination (e.g. Economides, 1998; Sand, 2004) and quality competition (e.g. Jaskold Gabszewicz and Thisse, 1979, 1980; Shaked and Sutton, 1982, 1983).

Section 2 introduces the model, discusses the incentives for vertical integration and derives the equilibria. In Section 3, I discuss the results of the model. The final Section 4 concludes.

2. The model

Consider two countries in which consumers are uniformly distributed on lines with length and density equal to one. All consumers demand one unit of the transportation service with valuation v. Additionally, consumers value the network densities of their operator in both countries. Two operators are located at both ends of the lines in both countries. I consider Operator 1 to have its home base in Country 1 whereas Operator 2 has its home base in Country 2.

By assuming Hotelling competition, I rule out intermodal competition. However, this assumption is not crucial for the following analysis. I discuss the consequences of relaxing this assumption in Section 3. Furthermore, the model assumes that both competitors are present on both markets. Unfortunately, we observe only a low degree of competition in long-distance passenger traffic in Europe. However, this observation is different for freight transportation. Competition has intensified significantly in recent years. For example, new competitors increased their market share in Sweden (45 percent), Estonia (30 percent) and Romania (26 percent) significantly. Even though not all entrants were originally the incumbents of other countries, market consolidation lead to the situation that other incumbents became the most relevant competitors within single European countries (DB, 2011).

The utility function of a consumer located at point x_j in Country j is defined as:

$$U_{x_j} = \begin{cases} v - p_{1j} + df_{1j} + ef_{1,-j} - tx_j & \text{if using Operator 1} \\ v - p_{2j} + df_{2j} + ef_{2,-j} - t(1 - x_j) & \text{if using Operator 2.} \end{cases}$$

In the utility function f_{ij} stands for the network density of Operator i in Country j, and t for the degree of differentiation between the operators. The price of Operator i in Country j is denoted by p_{ij}. d and e symbolize the valuation of density, defined by the combination of the number of routes and their frequency, in the home country and abroad respectively.

Network density increases the coverage and quality of the operators network because railway operators do not offer point to point connections per se. In contrast, they manage a network of connections. Hence, a higher density offers more connecting trains after the travel with a lower waiting time. These effects seem to be important for both, passenger traffic and freight transportation. This idea can be visualized by two exemplary network structures, a hub-and-spoke network and a matrix structure in Figure 1. In the hub and spoke, and matrix examples a passenger has to switch trains in order to travel from A to B. Hence, the more often the operator serves the individual routes and the more routes the operator offers, i.e. the denser the network is, the lower is the time it takes to travel or transport goods from A to B. Consequently, the denser the network the higher is the quality of the operator perceived by the customers. Furthermore, for passenger transportation the operator with the denser network of routes is able to offer a more suitable timing of the return trip; thereby, increasing the perceived quality of the two-way ticket.

Customers may be able to mix between operators, and choose different operators for the single legs. However, this comes at a cost. Buying tickets at different locations, and an uncoordinated timing of arrival

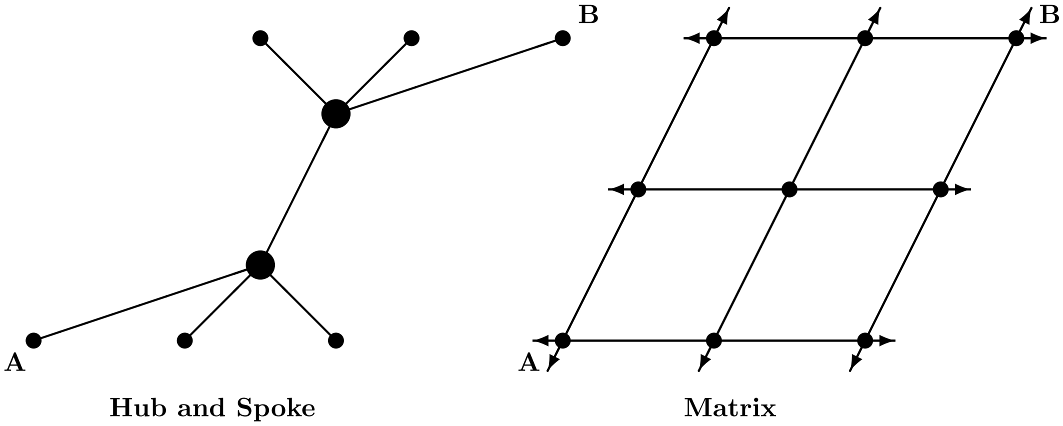

Figure 1: Exemplary stylized network structures

and departure decrease the comfort of traveling. Furthermore, mixing operators involves an additional risk for the customer that is also present in the airline market. In case of a delay the customer has to buy a new ticket for a connecting train. By traveling with only one operator the customer avoids that risk because typically the operator is responsible for the whole route and offers a new connecting train at no costs. Similarly, transferring freight from one operator to another involves higher costs compared to straight-through-processing. Schmidt (2001) provides some evidence by showing that interline shipment is more expensive for customers compared to single line shipment. Even though the possibility of mixing may set a limit to the pricing decision of the operators, a positive effect of density on consumer utility remains.

Even though cross country effects may exist on the supply as well as on the demand side, I concentrate on the demand side in the model. For simplicity, I assume that d and e are identical for all customers. This assumption is similar to assuming that d and e are distributed according to some distribution function among customers but independently of the position x_j on the line. In this case, d and e can be interpreted as the expected value of the distribution functions.

Deriving the marginal traders from the indifference conditions yields the following demand functions of Operator i in Country j:

$$x_{ij} = \frac{1}{2} + \frac{p_{-i,j} - p_{ij} + d(f_{ij} - f_{-i,j}) + e(f_{i,-j} - f_{-i,-j})}{2t}.$$

The infrastructure providers in the respective country offer time slots that grant operators the right to use the infrastructure. Infrastructure providers are regulated with respect to prices and offer slots at marginal costs. Hence, the infrastructure provider is not a player in my analysis. The number of time slots is directly related to the network density. Therefore, I use both terms synonymously. The operators' costs are composed by a marginal cost per seat, the access charge of the infrastructure provider and a cost factor quadratic in the network density (kf_{ij}^2). For simplicity, I assume the marginal costs of the infrastructure provider and the marginal costs of the operator per seat to be zero.

Because the access price is regulated, double marginalization effects or strategic price effects cannot play a role. However, bundling of services of the infrastructure provider and the operator within one firm leaves the firm the unregulated control rights. I assume that with AS these rights allow the discrimination of the competitor using price-independent mechanisms which results in an increase of the cost per time slot of the competitor by y. These additional costs are not transferred to the integrated firm, it simply increases the costs of the competitor. Throughout the model I assume for simplicity that y is "low" (see the Appendix for the details).

A report of the European Commission provides evidence for such behavior. The report states that "new entrant RUs reported many cases of discrimination in access to rail related services (...). Concrete examples of discriminatory practices on access to tracks and rail-related services include (...) denied access to central stations for international passenger trains competing with those of the incumbent, no information nor ticketing facilities in stations for these same trains; denied or very limited access to freight terminals when no alternatives are available" (EC, 2010, p.12). The OECD adds that the non-price discrimination practices might include "offering only undesirable time slots for the operation of trains or imposing unnecessary conditions for access. It might also involve conducting maintenance at times which affects the rivals trains or resolving delays in a manner which favors its own trains at the expense of the rivals" (OECD, 2005, p. 57). Safety regulations are another potential mechanism. A regulator may want to take these mechanisms into account but fail to do so because of the inherent difficulties (OECD, 2005). Merkert et al. (2008) provide some evidence by showing that the German model of AS increases the uncertainty faced by the competitors.[3]

Given these information, the profit functions of the operators are defined as:

$$\begin{aligned}
\Pi_{ij} &= \begin{cases} p_{ij}x_{ij} - kf_{ij}^2 & \text{if competitor is separated from infrastructure provider in Country j} \\ p_{ij}x_{ij} - kf_{ij}^2 - yf_{ij} & \text{if competitor is integrated with infrastructure provider in Country j} \end{cases} \\
\Pi_i &= \sum_j \Pi_{ij}. \qquad (1)
\end{aligned}$$

I impose an assumption on the parameter space that ensures the stability of the equilibria (see Dixit (1986) and the Appendix A.1 for the derivation).

Assumption 1.

$$(d+e)^2 < 9kt$$

Figure 2 summarizes the timing of the game. Governments decide about the unbundling alternatives in their countries simultaneously in the first stage, operators choose the network densities f_{ij} in the second stage and compete in prices simultaneously in the third stage.[4]

Because the model is a two country model, the objective function of the governments follows not straightforwardly. In general, I assume governments to maximize national welfare. However, it is unclear

[3]Online Appendix B provides additional (weak) evidence supporting this assumption by showing that market entry, measured by the ACCESS index published in IBM (2011), tends to be more difficult in AS countries compared to IS countries.

[4]All results are robust to a change of the timing. The related calculations can be found in the Online Appendix A.

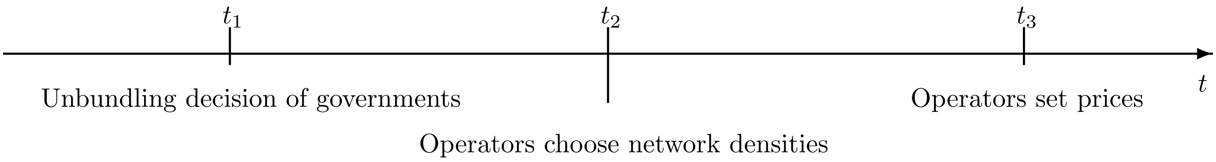

Figure 2: Timing of the game

whether the national governments value the profit of the national operator generated in both markets or whether they favor the profits generated by both operators in the home market. Therefore, I propose a welfare measure that weights the profits of the home market operator generated abroad and the profits of the foreign operator generated in the home market country j:

$$W_j \quad = CS_j + \Pi_{jj} + \alpha \Pi_{j,-j} + (1-\alpha)\Pi_{-j,j},$$

CS_j denotes the consumer surplus in Country j. There exist good reasons to believe that the government of a country is rather interested in the overall profits of the home country operator than in the profit the foreign competitor generates. Large parts of the value creation may take place in the operator's home country or the tax system hinders governments to raise taxes from foreign operators of the same scope as from home market operators. An alternative interpretation of the welfare function is that operators invest in lobbying activities in the sense of Grossman and Helpman (1994) and that the weights follow according to the lobbying investments.

In order to solve the model for the subgame-perfect Nash equilibrium, I calculate profits and welfare for the three different combinations of organization structures, i.e., complete separation, accounting separation in one country only, and accounting separation in both countries.

2.1. The price-setting stage

Maximizing profits with respect to the prices and solving the resulting system of equations gives:

$$p_{ij} = \frac{3t + d(f_{ij} - f_{-i,j}) + e(f_{i,-j} - f_{-i,-j})}{3} \quad \forall i, j.$$

The second order conditions are always fulfilled. Quite intuitively, the larger the density advantages in both countries the more the operator can raise its price. A larger density difference implies a larger difference in quality; hence, a higher price can be sustained. Because the different settings affect only the costs of time slots, the price-setting stage is identical for all three settings.

2.2. Complete separation

The complete separation case, i.e., institutional separation in both countries, is the baseline case, none of the operators has to take additional costs into account. Using the optimal prices from the price-setting stage in Eq. (1) gives the profit functions of the operators in the second stage:

$$\Pi_i = \sum_j \left(\frac{[3t + d(f_{ij} - f_{-i,j}) + e(f_{i,-j} - f_{-i,-j})]^2}{18t} - k f_{ij}^2 \right).$$

From these profit functions the subsequent reaction function for Operator i in Country j follow directly:

$$f_{ij} = \frac{3t(d+e) - (d^2+e^2) f_{-i,j} - 2de f_{-i,-j} + 2de f_{i,-j}}{18kt - d^2 - e^2}.$$

The second order conditions are fulfilled under Assumption 1. Since operators offer substitutable services, one may expect that densities of the competitors are strategic complements. However, the opposite is true, densities of competitors are strategic substitutes, i.e., $\frac{\partial f_{ij}}{\partial f_{-i,j}} < 0$ and $\frac{\partial f_{ij}}{\partial f_{-i,-j}} < 0$, while the densities of the same operator across countries are strategic complements, i.e., $\frac{\partial f_{ij}}{\partial f_{i,-j}} > 0$. The densities are associated with externalities across countries. Densities exert a positive effect on the profits abroad and increase the marginal revenues from densities. The opposite is true for densities of the competitor. These characteristics should be kept in mind for the following analysis.

Solving the system of network density reaction functions leads to equal sharing of the markets and the following optimal prices and densities:

$$p_{ij}^{sep} = t \quad \forall i, j$$
$$f_{ij}^{sep} = \frac{d+e}{6k} \quad \forall i, j.$$

These results are quite intuitive and replicate standard results from the economics of network industries (e.g., Shy, 2001). In the complete separation setting, both companies are completely symmetric and offer the same network densities. Hence, the relative evaluation of operators by the consumers depends only on the differentiation between them, which is the only factor that influences the price. Nonetheless, the larger the consumer valuation of densities, the larger are the potential gains for operators of increasing the network density; therefore, both choose a higher density. Clearly, higher costs of network densities decrease the demand via the same mechanism.

The profits, consumer surplus and welfare follow directly:

$$\Pi_{ij}^{sep} = \frac{18kt-(d+e)^2}{36k} \quad \forall i, j,$$
$$CS_j^{sep} = \int_0^{x_{1j}} (v - p_{1j} + df_{1j} + ef_{1i} - tx)dx + \int_{x_{1j}}^1 (v - p_{2j} + df_{2j} + ef_{2i} - t(1-x))dx$$
$$= \frac{12kv + 2(d+e)^2 - 15kt}{12k} \quad \forall j,$$
$$W_j^{sep} = \frac{36kv + 4(d+e)^2 - 9kt}{36k} \quad \forall j.$$

Consumer valuation of network densities decreases profits because of the rent-seeking characteristics of the competition model. The higher d and e are the denser are the networks. Because operators are symmetric, none of the operators has a relative advantage in equilibrium. Even worse, both have to bear the higher costs. Operators would be better off coordinating on lower network densities. A larger k has the opposite effect, operators offer lower densities and the profits increase.

The reverse is true for the consumer surplus. Consumers favor densities; hence, consumer surplus increases in d and e, and decreases in k and t via the same mechanism. The positive effect of d and e on consumer surplus dominates for the welfare payoff.

2.3. The effects of accounting separation

2.3.1. Accounting separation in one country

Within the proposed framework I can analyze the role of accounting separation. In this section I describe first the consequences of AS in one country, and turn then to the effects of AS in both countries. The technical details are delegated to the proofs of the Lemmas in the Appendix.

In the following, I use the example of AS in Country 1. The results hold with a reversed order for AS in Country 2. Integration with separated accounts in Country 1, raises the cost per time slot for the foreign Operator 2 in Country 1 by y. While the price setting stage of the game is unaffected by the change, the increased costs influence the density choice, leading to a lower network density of Operator 2 in Country 1.

The lower density of Operator 2 decreases marginal revenues of network density of Operator 2 in Country 2, while it increases marginal revenues of Operator 1 in both countries. This leads to a lower density of Operator 2 in Country 2 and a higher density of Operator 1 in both countries. These changes in the network densities influence the price game in the third stage. The difference in densities gives Operator 1 a competitive advantage who is, therefore, able to demand higher prices.

Consequently, the changes in network densities also affect the firm profits, consumer surplus and welfare. For a sufficiently low cost increase y the following results hold:

Lemma 1. *If Government 1 chooses accounting separation and Government 2 institutional separation, the following results hold in comparison with complete separation:*

1. *The profit of Operator 1 increases; the profit of Operator 2 decreases.*
2. *Consumer surplus decreases in both countries.*
3. *Welfare in Country 2 decreases; welfare in Country 1 increases if α and e are sufficiently high.*

Proof. See the Appendix A.2.

A high valuation of international network densities increases the competitive advantage of Operator 1 which leads to higher profits that compensate for the loss of consumer surplus. This is a somehow surprising result because barriers to competition are usually perceived as bad for a society. However in this setting, the government of Country 1 may have an incentive to accept less competition in the home market in order to strengthen its operator for competition in Country 2. It may have incentives to create a national champion. This result holds even though the integration decision implies additional costs that are wasteful for society, i.e., these costs are real costs and not a tax from which a government profits. The integration decision involves a negative externality for Country 2; hence, it is at the cost of the government of Country 2.

2.3.2. Accounting separation in both countries

With accounting separation in both countries the costs of network density for Operator 1 in Country 2 are higher, too. Compared to AS in Country 1 only, the advantage of Operator 1 diminishes. The increased costs lower the marginal revenue for densities of Operator 1 in both countries and Operator 1 lowers both types of densities. The contrary is true for Operator 2. Compared to complete separation, both operators choose a higher density at home and a lower density abroad.

Lemma 2 summarizes the consequences for the operator profits, consumer surplus, and welfare for a sufficiently low y.

Lemma 2.

1. *If Government 1 has chosen accounting separation and Government 2 chooses accounting separation as well, then the result of Lemma 1 hold for Operator 2 and Country 2.*
2. *If both governments choose accounting separation, consumer surplus, and welfare are lower in both countries compared to a separated industry structure. Operator profits are identical.*

Proof. See the Appendix A.3.

Even though the direct consequences of the unbundling decisions are independent of each other, each decision exerts a negative externality on the competitor and the consumers. This externality offsets the positive effect of AS. However, consumers in both countries are worse off because of a lower network density. Consequently, welfare is lower with accounting separation in both countries compared to complete separation. This implies that welfare is lower even though it might be higher for the "integrated" country in the asymmetric case.

2.4. The unbundling decisions

Based on the preceding analysis of the three different settings, the equilibrium of the unbundling decisions from the perspectives of the national governments follows directly. Lemma 1 states that governments do not choose AS unilaterally if α and e are small. Such a parameter constellation leads to lower welfare irrespectively of the choice of the other country's government. Hence, the resulting equilibrium has a separated industry structure in both countries. This equilibrium is pareto-optimal for both governments compared to any other industry structure.

In contrast, operators choose AS unilaterally if α and e are sufficiently large. By Lemma 2 this leads under the same conditions to AS of the competing operator and, hence, to AS in both countries in equilibrium. AS works as a barrier to competition which favors the home country operator but is at the cost of the competitor and the consumers.

Unfortunately, both governments are in equilibrium worse off than with complete separation. The desire to create national champions decreases individual national and overall welfare. The additional domestic profit of the home country operator cannot offset the loss of consumer surplus and profit of the competitor. Hence, governments are confronted with a Prisoner's dilemma. Both have incentives to choose accounting separation but would be better off in coordinating on institutional separation.

Proposition 1. *The resulting industry structure depends on the weight of the welfare function and the importance of network densities:*

- *If α or e are sufficiently small, the industry ends up in complete separation. The equilibrium is pareto-optimal.*

- *If α and e are sufficiently large, the industry ends up in accounting separation in both countries. Governments are confronted with a Prisoner's Dilemma; welfare in both countries is lower compared to complete separation.*

In the case of high importance of international network densities, both governments want to make their operator strong in competing with the foreign operator and opt for AS. Unfortunately, this leads to AS in both countries and none of the governments can take advantage of the integration decision. AS abroad decreases the profit of the home market operator at the same amount as AS at home raised it. However, the consumers stay worse off which decreases welfare.

This result has familiarities to models of strategic trade competition. Brander and Spencer (1985) show that export subsidies help to enhance the competitive position of domestic firms in a third market. In equilibrium producing countries impose a subsidy, even though they are jointly suboptimal. Instead of a quantity subsidy, I introduce an additional cost for the foreign competitor which makes the supply of density for her more costly. A lower density decreases the competitive position of the foreign firm in both countries and leaves the domestic firm better off. Furthermore, competition takes place in the domestic markets and influences not only firm profits but also consumers.

3. Discussion

Vertically integrated operators (with separate accounts) emphasize very often the importance of efficiency gains, or transaction cost savings, in a vertically integrated firm. Transaction cost savings, defined as gains from joint production[5], within an integrated firm may come from several sources. Variable costs, and lower fixed costs are the most prominent ones[6]. Against the background of the model, fixed cost savings are cost savings that are unrelated to the allocation of the number and quality of the slots. Fixed cost savings can be realized for example through better coordination in joint investments of the setup of train paths or simply by avoiding the duplication of certain administrative functions. In contrast, variable costs savings are all savings that are related to the allocation of the number and quality of the slots. Examples of areas where variable costs may be lower within an integrated firm are the negotiations about timetables[7], the track access agreements or performance regimes, or the safety planning and enforcement process (Merkert et al., 2012); though many of these areas may also affect the fixed costs of the two firms.

By neglecting cost savings the model biases against AS. However, introducing fixed or variable costs savings does not influence the comparative statics of the model. They only decrease the cut-off values of α and e beyond which AS becomes profitable for national governments.[8] Consequently, they may influence the evaluation of the equilibrium. If either of the cost savings is sufficiently high, the IS equilibrium may not be welfare inferior anymore. Lower fixed costs may compensate for the loss in consumer surplus. Similarly, variable costs savings may lead to lower prices, an increase in consumer surplus and firm profits; potentially outweighing the social costs of restricted access to the infrastructure and benefiting the whole society.

However, the existence of lower costs or efficiency gains within a integrated firm is unclear[9]. This article analyzes potential effects of AS in the absence of such cost savings. It is rather obvious that operators favor bundling even if these cost savings do not exist as long as bundling allows the firm to discriminate competitors in other ways. More surprisingly, the key result of my model is that also governments may favor AS, even if it is a pure anti-competitive effect and not associated with any kind of cost saving. The payoff to the national government may increase by unilaterally deciding to separate only the accounts of the home market incumbent even if bundling of infrastructure and operations is associated solely with additional costs for the competitor and without any productive function. For large cross-country spill-overs via the network effect the discrimination of the entrant comes with advantages for the national operator abroad which outweighs the additional costs for consumers. National governments

[5]Joint production avoids "market" transactions of two separated organizations.

[6]A potential double marginalization effect, and hold-up problems that are related to specific investments can be also described as part of the transaction costs. However, they can be only of minor importance because the access price of the infrastructure owner is typically regulated.

[7]For the same price tracks at better times are more valuable.

[8]Obviously, introducing fixed costs has only level effects and do not influence the density and price choice of the operators. Introducing variable costs savings gives a relative advantage to the home-market operator similarly as the non-price discrimination effect of AS. Thereby, both effects take on the same direction.

[9]See the discussion of the empirical literature on p. 4.

have incentives to create a national champion. In a globalizing world the importance of cross-border transportation is of high importance, highlighting the relevance of this result.

However, this argument holds for both operators, and in equilibrium both governments choose the bundled structure and are worse off than with complete separation. This outcome emphasizes the need for supranational cooperation, justifies the efforts of the European Union to liberalize the markets, and the introduction and strengthening of the European Railway Agency (ERA). The international cooperation serves as a mechanism to commit to discriminatory-free access[10].

In the current debate about the structure of the market in Europe some operators complain that the opening of national markets takes place at different pace among European countries (e.g., IBM, 2011), e.g., in some countries the passenger segment is still closed for foreign operators. The model delivers two explanations for this observation. First, countries differ with respect to their perceived importance of international traffic. For example, against the background of the analysis it is not a surprise that the United Kingdom was the pioneer among European countries in liberalizing their railway market. Because of Britain's geographical characteristics, cross-border transportation by train is just not a big issue. The island is connected by train to continental Europe only by the Eurotunnel and a few ferries. Furthermore, the strategy of the national incumbents differ. For example, the dutch national incumbent *Nederlandse Spoorwegen* did not enter any international market and is only active in the home-market. Consequently, creating a national champion in the sense of the model is not in the interest of the dutch government.

Second, AS may serve as a hidden mechanism to restrict access. Even though governments committed to open national markets, governments with operators active in other European markets have incentives to unilaterally delay the process in order to strengthen their home market operator in the short run. Additional regulatory initiatives are always a step behind; therefore, AS helps national governments to slow down the opening of their market in the transition period[11].

The model ignores an additional important factor in the railway market, intermodal competition. One may argue that bundling the services with separate accounts increases the attractiveness of the railway market. Assuming that railways are associated with less greenhouse gas emissions compared to the cars, trucks, planes or ships, increasing the modal share of railways comes with an additional benefit for the society. However, accounting separation decreases the attractiveness of the railway sector if AS allows discrimination of competitors. The model shows a lower consumer surplus compared to a completely separated industry structure. Hence, it decrease the attractiveness of the railway market as a whole which leads to a lower share of railways among all transportation modes. This result is also reflected by Table A.4 which shows that the network density is in sum lower in each country compared to complete separation.

A transfer of the results on other industries depends crucially on cross-country spill-overs. Without spill-overs the model becomes a simple single country analysis. Even though these spill-overs seem to be important for railways, this may be different for other network industries. For example, electricity generators need also access to the infrastructure in order to distribute energy. However, railways need not only a network of tracks but additionally a network of connections, something that is not present on the energy market.

4. Conclusion

The main contribution of the article is to shed light on the role of governments in the discussion of institutional separation, or access restrictions in more general, on the railway market. The incentives of the private companies are relatively obvious: being able to restrict access decreases the degree of competition and increases profits. The analysis shows that even national governments choose accounting separation for their national incumbent if international spill-over effects are large. Even though this is associated with a lower degree of competition, the additional profits of the incumbent abroad compensate for welfare losses at home. The lower degree of competition at home gives the incumbent a stronger position to compete abroad and to gain higher profits. Because the incentives for both governments are identical, both governments choose accounting separation.

[10] Three of the five goals of the ERA are related to competition and non-discriminatory access: "(...) encouraging market entry by reducing administrative and technical barriers", "(...) opening domestic rail passenger transport to competition", and "(...) encouraging market entry and ensuring non-discrimination through better governance of the infrastructure."

[11] A simple way to mitigate the problem in the two-country setup would be to offer access only on a reciprocal basis, as done by Hungary in the passenger market.

This result is true even though I do not take the main argument favoring bundling into account: transaction cost savings. In my modeling approach, AS is solely associated with additional costs for the competitor. Even though there is no productive function of accounting separation, it is associated with advantages for the governments. Unfortunately, the resulting equilibrium is associated with lower national and overall welfare compared to separated structures.

Even though the final evaluation of the organization form depends crucially on potential efficiency gains within an integrated firm, this result shows that even national governments may hide behind this argument in order to strengthen their national incumbent.

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A. Appendix

A.1. Stability condition of the equilibrium

Beside the validity of the second order conditions I need to ensure the stability of the equilibrium (see Dixit, 1986).

$$\begin{bmatrix} \dot{f}_{11} \\ \dot{f}_{12} \\ \dot{f}_{21} \\ \dot{f}_{22} \end{bmatrix} = \begin{bmatrix} \frac{\partial^2 \Pi_i}{\partial f_{11}^2} & \frac{\partial^2 \Pi_i}{\partial f_{11}\partial f_{12}} & \frac{\partial^2 \Pi_i}{\partial f_{11}\partial f_{21}} & \frac{\partial^2 \Pi_i}{\partial f_{11}\partial f_{22}} \\ \frac{\partial^2 \Pi_i}{\partial f_{12}\partial f_{11}} & \frac{\partial^2 \Pi_i}{\partial f_{12}^2} & \frac{\partial^2 \Pi_i}{\partial f_{12}\partial f_{21}} & \frac{\partial^2 \Pi_i}{\partial f_{12}\partial f_{22}} \\ \frac{\partial^2 \Pi_i}{\partial f_{21}\partial f_{11}} & \frac{\partial^2 \Pi_i}{\partial f_{21}\partial f_{12}} & \frac{\partial^2 \Pi_i}{\partial f_{21}^2} & \frac{\partial^2 \Pi_i}{\partial f_{21}\partial f_{22}} \\ \frac{\partial^2 \Pi_i}{\partial f_{22}\partial f_{11}} & \frac{\partial^2 \Pi_i}{\partial f_{22}\partial f_{12}} & \frac{\partial^2 \Pi_i}{\partial f_{22}\partial f_{21}} & \frac{\partial^2 \Pi_i}{\partial f_{22}^2} \end{bmatrix} \begin{bmatrix} f_{11} - f_{11}^{sep} \\ f_{12} - f_{12}^{sep} \\ f_{21} - f_{21}^{sep} \\ f_{22} - f_{22}^{sep} \end{bmatrix}$$

For stability, the coefficient matrix should have negative eigenvalues. This is the case if:

$$9kt > (d+e)^2.$$

I impose this as an assumption for my analysis. The assumption ensures not only stability, but also the fulfillment of the second order conditions and the non-negativity of operators' profits.

A.2. Proof Lemma 1

AS in Country 1 increases the costs of network densities of Operator 2 in Country 1. This cost increase changes the reaction function of Operator 2 in Country 1 to

$$f_{21} = \frac{3t(d+e) - (d^2+e^2)f_{11} - 2def_{12} + 2def_{22} - 9ty}{18kt - d^2 - e^2}.$$

Even though all other reaction functions remain unchanged, this change affects the marginal revenues of the other network densities.

Table A.1 summarizes the resulting equilibrium network densities. Superscript 1 denotes AS in Country 1 only, superscript 2 denotes AS in Country 2 only, and superscript b denotes AS in both countries. For the sake of simplicity I define $M_1 = 9kt - (d+e)^2 > 0$, and $M_2 = 9kt - (d-e)^2 > 0$.

f_{ij}^1	**Country 1**	**Country 2**
Operator 1	$f_{ij}^{sep} + \frac{M_1(d^2+e^2)+2de(d+e)^2}{4kM_1M_2}y$	$f_{ij}^{sep} + de\frac{9kt}{2kM_1M_2}y$
Operator 2	$f_{ij}^{sep} - \frac{M_1M_2+9kt[9kt-(d^2+e^2)]}{4kM_1M_2}y$	$f_{ij}^{sep} - de\frac{9kt}{2kM_1M_2}y$

Table A.1: Densities of Operator i in Country j with AS in Country 1

The changes in the network densities influence the price game in the third stage. The difference in densities gives Operator 1 a competitive advantage who is, therefore, able to demand higher prices. The effects on prices and market shares are summarized in Table A.2.

		Country 1	**Country 2**
p_{ij}^1	**Operator 1**	$p_{11}^{sep}[1 + 3d\frac{9kt-(d^2-e^2)}{2M_1M_2}y]$	$p_{12}^{sep}[1 + 3e\frac{9kt+(d^2-e^2)}{2M_1M_2}y]$
	Operator 2	$p_{21}^{sep}[1 - 3d\frac{9kt-(d^2-e^2)}{2M_1M_2}y]$	$p_{22}^{sep}[1 - 3e\frac{9kt+(d^2-e^2)}{2M_1M_2}y]$
x_{ij}^1	**Operator 1**	$x_{11}^{sep} + 3d\frac{9kt-(d^2-e^2)}{4M_1M_2}y$	$x_{12}^{sep} + 3e\frac{9kt+(d^2-e^2)}{4M_1M_2}y$
	Operator 2	$x_{21}^{sep} - 3d\frac{9kt-(d^2-e^2)}{4M_1M_2}y$	$x_{22}^{sep} - 3e\frac{9kt+(d^2-e^2)}{4M_1M_2}y$

Table A.2: Prices and market shares of Operator i in Country j with AS in Country 1 only

These equilibrium prices and densities allow the derivation of profits, consumer surplus and welfare. I use these measures to calculate the difference per unit increase of y evaluated at $y \to 0$. I denote the resulting differences as Γ. This approach assumes y to be low and asks whether the introduction of such costs evaluated at $y = 0$ gives positive or negative differences in the variables of interest.[12] I show this procedure exemplary for the profit of Operator 1 and deliver afterwards only the relevant measures for the other functions of interest. From the equilibrium densities follows the profit difference of Operator 1:

$$\Pi_1^1 - \Pi_1^{sep} = \frac{1}{48kM_1^2M_2^2}\{4(d+e)(18kt-(d-e)^2)M_1M_2^2 + 3y\left[(d^2+e^2)M_1M_2(18kt-(d^2+e^2)) + 4d^2e^2(M_1M_2+162k^2t^2)\right]\}y.$$

Dividing by y and taking the limit gives:

$$\Gamma_{\Pi_1^1-\Pi_1^{sep}} \equiv \lim_{y\to 0}\frac{\Pi_1^1-\Pi_1^{sep}}{y} = \frac{(d+e)[18kt-(d+e)^2]}{12kM_1} > 0.$$

Table A.3 shows that the higher network densities lead to a higher profit of Operator 1. Operator 1 sets higher prices and gains higher market shares; hence, he earns higher profits. The reverse holds for Operator 2.[13]

$\Gamma_{\Pi_{ij}^1-\Pi_{ij}^{sep}}$	**Country 1**	**Country 2**	**Sum**
Operator 1	$\frac{18dkt[9kt-d(d+e)]-(d+e)(d-e)^2M_1}{12kM_1M_2}$	$\frac{3et[9kt-e(d+e)]}{2M_1M_2} > 0$	$\frac{(d+e)[18kt-(d+e)^2]}{12kM_1} > 0$
Operator 2	$-\frac{18dkt[9kt-d(d+e)]-(d+e)(d-e)^2M_1}{12kM_1M_2}$	$-\frac{3et[9kt-e(d+e)]}{2M_1M_2} < 0$	$-\frac{(d+e)[18kt-(d+e)^2]}{12kM_1} < 0$

Table A.3: Evaluation of profit differences compared to complete separation

Consumers traveling with Operator 1 experience higher densities and higher prices. The contrary is true for consumers traveling with Operator 2. However, for both groups the negative effect dominates and the consumer surplus is lower with AS in one country compared to complete separation.

$$\Gamma_{CS_1^1-CS_1^{sep}} = -\frac{d}{4k} < 0$$
$$\Gamma_{CS_2^1-CS_2^{sep}} = -\frac{e}{4k} < 0$$

Consequently, welfare in Country 2 is also lower. In contrast to this negative effect, the effect on welfare in Country 1 is unclear and depends on α and e.

$$\Gamma_{W_1^1-W_1^{sep}} = \alpha\frac{(d+e)(18kt-(d+e)^2)}{12kM_1} - \frac{d}{4k} \gtreqless 0$$
$$\Gamma_{W_2^1-W_2^{sep}} = -\alpha\frac{(d+e)(18kt-(d+e)^2)}{12kM_1} - \frac{e}{4k} < 0$$

In order to show that $\Gamma_{W_1^1-W_1^{sep}}$ becomes positive with increasing e, one can plug in the lowest and the largest possible e to $\Gamma_{W_1^1-W_1^{sep}}$ and then check the derivative for monotonicity:

$$\Gamma_{W_1^1-W_1^{sep}}(e=0) = d\frac{9kt\alpha-(3-\alpha)(9kt-d^2)}{12kM_1} \gtreqless 0 \tag{A.1}$$

$$\lim_{e\to\sqrt{9kt}-d}\Gamma_{W_1^1-W_1^{sep}} \to +\infty \tag{A.2}$$

$$\frac{\partial\Gamma_{W_1^1-W_j^{sep}}(e)}{\partial e} = \alpha\frac{9kt[18kt-(d+e)^2]+(d+e)^4}{12kM_1^2} > 0 \tag{A.3}$$

Notice that even though (A.1) may be either positive or negative (depending on d and α) (A.2)

[12] In the case of integration in one country only, the approach is identical to taking the derivative of the variable of interest with respect to y and evaluating the derivative at $y = 0$.

[13] The table also shows that everything Operator 1 wins is lost by Operator 2. However, note that this observation is due to the fact that the profit functions have a minimum at $y = 0$ and marginal profits are therefore zero.

increases to infinity as long as $\alpha > 0$. Given monotonicity of $\Gamma_{W_1^1 - W_j^{sep}}$ with respect to e, there exists an unique e^0 for which $\Gamma_{W_1^1 - W_j^{sep}} = 0$ whenever $\Gamma_{W_1^1 - W_j^{sep}}(e = 0) < 0$ as long as α is strictly positive.

Additionally, because $\frac{\partial \Gamma_{W_1^1 - W_j^{sep}(e)}}{\partial e}$ increases in α, e^0 decreases in α.

A.3. Proof Lemma 2

Accounting separation in both countries is the last setting which I need to consider. In this case, the reaction functions of network densities of both operators abroad change to:

$$f_{ij} = \frac{3t(d+e) - (d^2+e^2)f_{-i,j} - 2def_{-i,-j} + 2def_{i,-j} - 9ty}{18kt - d^2 - e^2} \quad \forall i \neq j.$$

Again, all second order conditions are fulfilled under Assumption 1. Compared to AS in Country 1 only, the advantage of Operator 1 diminishes. The increased costs lower the marginal revenue for densities of Operator 1 in both countries and Operator 1 lowers both types of densities. The contrary is true for Operator 2. Compared to complete separation, both operators choose a higher density at home and a lower density abroad.

With AS in both countries, operators have a density advantage in their home country and a disadvantage equal in size abroad. Compared to complete separation, operators are able to set higher prices at home but have to suffer lower prices abroad as long as $d > e$. Consequently, for $d = e$ no operator has a net advantage and prices are identical to complete separation.

		Country 1	**Country 2**
f_{ij}^b	**Operator 1**	$f_{11}^{sep} + \frac{(d-e)^2}{4kM_2}y = f_{11}^1 - de\frac{9kt}{2kM_1M_2}y$	$f_{12}^{sep} - \frac{18kt-(d-e)^2}{4kM_2}y = f_{12}^1 - \frac{M_1M_2+9kt(9kt-(d^2+e^2))}{4kM_1M_2}y$
	Operator 2	$f_{21}^{sep} - \frac{18kt-(d-e)^2}{4kM_2}y = f_{21}^1 + de\frac{9kt}{2kM_1M_2}y$	$f_{22}^{sep} + \frac{(d-e)^2}{4kM_2}y = f_{22}^1 + \frac{M_1(d^2+e^2)+2de(d+e)^2}{4kM_1M_2}y$
p_{ij}^b	**Operator 1**	$p_{11}^{sep}[1 + \frac{3(d-e)}{2M_2}y] = p_{11}^1[1 - 3e\frac{9kt+(d^2-e^2)}{2M_1M_2}y]$	$p_{12}^{sep}[1 - \frac{3(d-e)}{2M_2}y] = p_{12}^1[1 - 3d\frac{9kt-(d^2-e^2)}{2M_1M_2}y]$
	Operator 2	$p_{21}^{sep}[1 - \frac{3(d-e)}{2M_2}y] = p_{21}^1[1 + 3e\frac{9kt+(d^2-e^2)}{2M_1M_2}y]$	$p_{22}^{sep}[1 + \frac{3(d-e)}{2M_2}y] = p_{22}^1[1 + 3d\frac{9kt-(d^2-e^2)}{2M_1M_2}y]$
x_{ij}^b	**Operator 1**	$x_{11}^{sep} + \frac{3(d-e)}{4M_2}y = x_{11}^1 - 3e\frac{9kt+(d^2-e^2)}{4M_1M_2}y$	$x_{12}^{sep} - \frac{3(d-e)}{4M_2}y = x_{12}^1 - 3d\frac{9kt-(d^2-e^2)}{4M_1M_2}y$
	Operator 2	$x_{21}^{sep} - \frac{3(d-e)}{4M_2}y = x_{21}^1 + 3e\frac{9kt+(d^2-e^2)}{4M_1M_2}y$	$x_{22}^{sep} + \frac{3(d-e)}{4M_2}y = x_{22}^1 + 3d\frac{9kt-(d^2-e^2)}{4M_1M_2}y$

Table A.4: Densities, prices and market shares of Operator i in Country j with AS in both countries

Table A.4 shows that the differences in prices and densities between AS in both countries and AS in Country 1 only are identical to the differences shown in Tables A.1 and A.2. From this observation follows that the results from Lemma 1 hold equivalently for the case of AS of Operator 2. The same mechanisms are at work. There is no additional effect of AS in Country 1 on the (individual) incentives to choose AS in Country 2 and no changes to the incentives compared to Lemma 1.

However, even though the direct consequences of the unbundling decisions are independent of each other, each decision exerts a negative externality on the competitor and the consumers. Therefore, the comparison of complete separation and accounting separation in both countries is important for the equilibrium derivation. Table A.5 shows the relevant terms for the profits of the operators.

Lemma 1 and 2 state that everything Operator 1 wins by choosing AS is lost by Operator 2. Hence, the profits of operators neither increase nor decrease compared to a separated industry structure. The intuition behind this result is that AS gives both operators a strategic advantage in their home countries

$\Gamma_{\Pi_{ij}^{b}-\Pi_{ij}^{sep}}$	**Country 1**	**Country 2**	**Sum**
Operator 1	$\frac{(d-e)[18kt-(d^2-e^2)]}{12kM_2}$	$-\frac{(d-e)[18kt-(d^2-e^2)]}{12kM_2}$	0
Operator 2	$-\frac{(d-e)[18kt-(d^2-e^2)]}{12kM_2}$	$\frac{(d-e)[18kt-(d^2-e^2)]}{12kM_2}$	0

Table A.5: Evaluation of profit differences compared to complete separation

but a strategic disadvantage abroad. These advantages and disadvantages offset each other and the overall profits are identical to the case of separation.[14]

The effect on individual profits within a country depends on the relative size of d and e. It may be natural to assume that $d > e$. This assumption yields the intuitive outcome that home market profits increase while profits generated abroad decrease. For $d < e$the opposite holds true. In this case the international network effects dominate the national network effects and operators compensate lower home-market profits with higher profits abroad.

As a direct consequence of the results above, consumer surplus and welfare are lower with accounting separation in both countries compared to complete separation.

$$\Gamma_{CS_j^b-CS_j^{sep}} = \Gamma_{W_j^b-W_j^{sep}} = -\frac{d+e}{4k} < 0 \quad \forall j.$$

[14]Again this is because the profit function have their minimum at $y = 0$; hence, the first derivative is equal to zero.