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**ON THE MERITS OF OPEN ACCESS:
THE CASE OF RAILWAY
PASSENGER TRANSPORT REFORM
IN RUSSIA**

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The open access model of rail passenger sector in Russia is formally analysed to access the merits of complete vertical divestiture of the integrated infrastructure company (RZD) as an option for future reform. The establishment of Federal Passenger Directorate as an RZD's downstream affiliate may provide substantial economies of scope but create incentives to disadvantage its rivals in the form of cost-increasing sabotage. We found that the welfare gain from complete vertical divestiture may depend on the nature and toughness of downstream competition and be irrelevant to the size of scope economies and maximum level of sabotage. Open access model proves to be comparatively more attractive when downstream firms are constrained in their capacities, have quite similar costs and compete in prices.

JEL classifications: L51, L22.

Key words: downstream competition, constrained capacity, sabotage, railway reform, Russia.

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В работе рассматривается организационная модель открытого доступа, реализованная в ходе реформы пассажирского сектора железнодорожного транспорта России. Формальный анализ модели позволяет оценить преимущества и недостатки разделения вертикально интегрированной инфраструктурной компании («РЖД») как возможного направления дальнейшего реформирования отрасли. Функционирование Федеральной пассажирской дирекции в качестве структурного подразделения «РЖД» сохраняет экономию от вертикальной интеграции, однако создает стимулы к дискриминационному поведению в отношении независимых конкурентов (в форме манипулирования их издержками на конечном рынке пассажирских перевозок). Относительная привлекательность вертикального разделения, как показано в работе, может зависеть от природы и интенсивности конкуренции на конечном рынке и не зависеть от величины экономии от вертикальной интеграции и максимально допустимого уровня саботажа. Модель открытого доступа предпочтительна в том случае, когда ограниченные в производственных возможностях фирмы-операторы имеют схожие издержки и конкурируют по ценам.

Классификация JEL: L51, L22.

Ключевые слова: конкуренция на конечном рынке, ограниченные мощности, саботаж, реформы железнодорожного транспорта, Россия.

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1. Introduction and background

The pros and cons of vertical integration of infrastructure and operations in the railroad industry has traditionally nourished the reform agenda and very often polarized the political debate on the merits of vertical divestiture. The arguments in favor of importance and desirability of vertical integration in the network industries range from the better operational coordination and economies from sharing common costs to technological and productive efficiency and incentives to innovate¹. Disadvantages of vertical integration are also well known: hierarchies tend to monopolise certain markets and are reputed to re-
sponse slowly to demand shocks. Moreover, their regulation becomes more complicated and requires more resources. The last argument is especially pronounced when the downstream market (train operations) is open for competition: the infrastructure owner who also provides end-user services may have means and incentives to discriminate its non-integrated downstream rivals. In such a vertical access model the problem of making on-track competition viable becomes comparatively more regulatory intensive. In transition economies the institutional weakness and insufficient competence of regulatory and anti-monopoly authorities make them supportive of vertical separation² while railway monopoly managers and industry specialists often advocate the opposite solution for the railroad industry. The ongoing debate on the railway reform in Russia perfectly illustrates such a contradiction.

Adopted in 2001 the three-stage reform program lacked the detailed description of target industry structure by the end of the process in 2010. Nevertheless the program called for the vertical access model at least at the intermediate stage of reform. This sort of incremental approach to industry transformation compromised to some extent the two polar approaches and made the long-expected structural reorganization possible³. The second stage of reform started in 2003 with the establishment of the Russian Railways Joint Stock Company (RZD) wholly owned by the Government. Competition in the market for wagon provi-

¹ See the Seabright (2003), Ksoll (2004) and Pittman (2005) for the detailed analysis of such arguments with application to railway transport.

² See Pittman (2003a, 2003b).

³ OECD (2004) and OECD (2007 update) report the details and progress of the reform.

sion in the freight sector was legalized⁴ by the adoption of the new freight tariff system in 2003 (so called Price Courant #10-01 introduced a discount from differentiated transportation tariffs for operators using their own or leased wagons). The adoption of 'Rules on the provision of non-discriminatory access to infrastructure' in 2003 equipped the antimonopoly authority with a necessary instrument to secure equal treatment for all carriers and operators.

These and other measures of regulatory reform opened the room for on-track competition. Not surprisingly, it emerged firstly in the most lucrative markets (eg. transportation of oil and high value-added commodities). The industry structure changed and the financial stability of the RZD challenged. Dementiev (2007) argues that if the vertically integrated company, like RZD, is closely regulated on the downstream market which is open for competition, such a company would implement a set of 'defensive' strategies to deal with competition from the private sector. These competitive strategies would include (but not be limited to) different methods of rivals discrimination and/or self-restructuring. Indeed the next step of reform in 2007 was the establishment of the First Freight Company (FFC) as an operator of rolling stock wholly-owned by RZD. The First Freight Company received about 200,000 mostly specialized freight wagons (out of 520,000 owned by RZD). The main idea was to escape from tariff regulation and concentrate the business activity on the niche markets which turned out to be financially more attractive but to large extent 'cream-skimmed' by independent operators. It is envisaged that in the mid-term one of the biggest freight company in the world, as the FFC proved to be with the assessed capitalization of \$5bln, will be partially privatized through IPO.

Accomplishments in the passenger sector are less impressive and maybe characterized as 'pending departure'. The new tariff system (known as Price Courant #10-02-16) has been drafted but never officially adopted. It has been designed to distinguish between 4 types of charges — for the use of railway infrastructure, stations, locomotives and wagons — and aimed at encouraging investments in passenger rolling stock (wagons and, possibly, locomotives). Instead, the passenger ticket fare has been consisting of the two components — the 'platzkarte' (charge for the seat) and 'billett'(charge for the transporta-

⁴ The rush to adopt the structural reform plan in 2001 and elaborate the new Price Courant #10-01 in 2003 was explained by the need to deal with rolling stock shortage in the freight sector on the wave of economic upheaval in Russia. On the eve of reform approximately one fourth of the car fleet was private. However the incentives to modernize existing and invest in new wagons were absent because private wagon owners had to pay the same tariff for transportation as those shippers who used RZD wagons. The new tariff system legalized previously informal discounts from transportation tariff for the private wagon owners.

tion) — with no clear reference to any type of costs covered by each of these components. Interestingly, the lack of transparent rules for access to RZD infrastructure and corresponding tariffs (which would private operators wish to pay for the use of RZD's infrastructure, locomotives and stations) didn't prevent private passenger companies from starting their operations on some routes. This phenomenon is the major concern and motivation of this paper.

To sum up, during the first 6 years of reform the railroad industry in Russia evolved from the monolithic state ministry to the following structure: vertically integrated state-owned infrastructure company — RZD — being the only licensed carrier on its network, its affiliates serving as specialized freight operators (FFC, TransContainer, RailTransAuto, RefService), Federal Passenger Directorate⁵, 10 suburban and regional passenger companies and about 2500 private operators with their own wagon fleet. Among them there are two private intercity passenger companies — Grand Express and Megapolis — both operating on Moscow-St. Petersburg route and competing in both middle and luxury price segments with RZD trains⁶. The very emergence of on-track competition in the passenger sector at this stage of reform and possible RZD's strategic actions (like transformation of the Federal Passenger Directorate to a more institutionally independent Federal Passenger Company — FPK) as a next step of reform deserves theoretical and empirical investigation. In this paper we attempted this kind of research at two levels.

At the theoretical level this paper develops an analytical framework that enables one to grasp the complex system of different arguments in favor of and against the complete divestiture of the vertically integrated provider (VIP) of essential facility (access to infrastructure) that faces competition downstream. We endow the VIP with an ability to discriminate (or sabotage) its' rivals by raising their costs. In the formal model we analyze discriminatory activities of the VIP under different institutional settings and consider welfare implications under different assumptions about the toughness of downstream competition in the rail passenger market to answer the question when the vertical divestiture may be welfare improving. We found that the welfare gain from the vertical divestiture may depend on the type of regulation applied to the vertically-integrated railway monopolist (RZD) and be conditioned by the nature and toughness of

⁵ The term 'directorate' (or 'branch') stands for the separate division within RZD structure with virtually no business autonomy. Under such an institutional arrangement even accounting separation is in doubt since the officially reported financial results of the Directorate may be misleading because the methodology of splitting the shared costs between freight and passenger services has always been questionable.

⁶ The third private company 'Passazhirskie Perevozki' operates suburban trains and serves budget (or low-price) passengers in the same route.

downstream competition. These findings shed some light on the optimal path for the passenger railway transport reform in Russia.

The paper also addresses the problem of vertical divestiture at the empirical level providing some evidence to support basic assumptions made in the theoretical model. Thus the purpose of this research is to assess the prospects of competition in the passenger sector and formulate some policy recommendations concerning the reform measures to be taken in the future.

The remainder of the paper is organized as follows. Section 2 surveys the existing literature relevant for the formal analysis of the vertical access model to do welfare comparisons of alternative industry structures. Section 3 analyzes the institutional environment (formal and informal) of the passenger railway transport reform in Russia and defines four principle regulatory schemes at the different stages of reform: preparatory, vertical access with downstream regulation, vertical access with unregulated downstream market and possible future configuration — complete vertical divestiture of the VIP. A simple theoretical framework inspired by Sappington (2006a) is built in Section 4. We depart from the original setup in our treatment of the nature of downstream competition. The main findings are discussed in Section 5. Section 6 concludes.

2. Related literature

The railroad industry in Russia is characterised by the situation when infrastructure monopoly both serves the end-user (downstream) market and provides the essential facility to its downstream competitors. Such a vertical access model has attracted considerable attention of economists, industry specialists and policymakers. Intuitively, vertically integrated service provider (VIP) may benefit from discriminating against non-integrated downstream rivals and thereby hinder industry performance. To level the playing field at the potentially competitive downstream market policymakers often adhere to the vertical separation approach so as to prevent the infrastructure owner from sabotage (or treating different operators in a different way).

However since it is not uncommon for the railway industries to exhibit substantial economies of scope, such a vertical unbundling strategy may increase the costs of service at each stage of production and decrease total welfare. Traditionally, the trade-off between economies of vertical integration and welfare gains from tougher downstream competition has been treated as a country-specific question to be studied empirically. In our paper we try to follow the recent

research agenda to incorporate sabotage as a strategic variable in the model of competition in the vertically related market.

The economic literature on sabotage distinguishes between cost-raising (see Beard et al., 2001) and demand reducing types of such a discriminatory activity (Mandy and Sappington, 2007). It is generally acknowledged that if raising the costs of downstream rivals is costless sabotage makes sense for the VIP (Sappington, 2006b). In Cournot settings (e.g., Economides, 1998; Sibley and Weisman, 1998) when downstream firms compete in quantities, as well as in case of competition in prices *a la* Bertrand (e.g., Weisman, 1995; Beard et al., 2001; Kondaurova and Weisman, 2003) cost-raising sabotage by the VIP brings about an increase in the profit of its downstream affiliate. This type of sabotage induces downstream competitors to produce less that would lead to a decrease in the demand for the final product. In turn the upstream profit decreases if there is some mark-up over marginal cost on the upstream market ((e.g., Weisman, 1995; Sibley and Weisman, 1998). Thus, the potential trade-off between downstream gains (measured by the consumers' surplus) and losses from the diseconomies of scope (or vertical integration) worth considering.

This approach may be directly applied to the analysis of *pros and cons* of vertical divestiture of the VIP that faces downstream competition and the answer may depend on the assumptions about its nature and fierceness. Crew et al. (2005) investigate the Cournot competition and argue that vertical divestiture can eliminate sabotage at the expense of scope economies gain. The policymakers must evaluate the potential for sabotage vs. scope economies (embodied in smaller costs of the downstream production of the VIP affiliate). If the former exceeds the latter vertical separation is preferred, otherwise integrated production is to be chosen. If the downstream firms engage in Bertrand competition (see Sappington, 2006a) this result doesn't hold anymore: even when scope economies are high and potential for sabotage is limited the vertical separation secures higher level of expected consumers' surplus comparing to vertical integration.

Adopting similar approach we contribute to this literature in the following. We assume that downstream competitors (the VIP affiliate, operating rival and any potential entrant) have pre-commitments about their production potentials and compete in prices. So their capacities turned out to be constrained and constant in the short-run. We also assume that any two rivals can capture the whole downstream market but none of them have enough facilities to drive its rival out the market completely. This assumption appears to be crucial to our findings but doesn't seem implausible if we want to analyze discrete structures of the industry or further reform measures. The following section provides some rationale behind this and other assumptions of the model.

3. Stylized facts of the reform

To substantiate our formal analysis we start with reporting some important stylized facts about the regulatory framework and market conditions at different stages of railway reform in Russia. We focus on the intercity rail passenger services.

It is the regulatory policy together with demand shocks, rolling stock depletion, the lack of adequate financing and consequent underinvestment in quality of service and other reason that influenced the emergence of competition in the market for intercity passenger services. Originally, competition took the form of open tenders for outsourcing activities taken by private companies for RZD and were limited to catering, laundering, etc. As these companies matured and got necessary experience and qualification they started to operate passenger trains (with private wagon or wagons leased from RZD) under their own brand names. Obviously, they entered probably the most attractive market for intercity passenger services in Russia, the Moscow — St. Petersburg ‘golden route’, with a hope that future financial gains would eventually outweigh the costs of all the entry barriers and other difficulties resulted from (potential) RZD’s discriminatory activities.

The entry decision was also based on the assessment of regulatory environment in the industry. The Figure 1 below demonstrates that regulatory policy happened to be quite favourable for the rail passenger market since real passenger tariffs (average 2nd class passenger ticket fare compared to CPI) substantially increased during the reform period and become more flexible and seasonally adjusted. These changes in tariff dynamics reflect the fact that 2nd and higher class ticket fares were effectively unregulated in 2003.

Several features of the market structure (in particular the degree of vertical separation), extent of competition and regulatory policy are crucial for further analysis. In terms of these three major dimensions of the structural reform in Russia⁷ the rail passenger transport reform may be described by four principal structural schemes.

The industry structure at the first stage of reform (the preparatory phase), which we will call Scheme #1, was characterized by the model of vertical integration with downstream tariff regulation and virtually no way to have access to infrastructure by independent operator.

Scheme #2 stands for the vertical access model when VIP affiliate is strictly regulated but its competitive fringe is unregulated. This structural scheme may deserve special research efforts but such an ‘overregulated’ vertical access

⁷ See Nash (2007) for the assessment of the reform progress of European passenger railways.

model has never experienced any competitive pressure from independent train operators in Russian passenger market. It’s worth mentioning here that being free to choose the market segments to enter independent passenger train operators would consider first of all the most lucrative markets. Among them the rail link between the two capitals — Moscow and St. Petersburg — appears to be the most promising one. The market however did remain closed for competition until tariffs were unregulated. The fares for 2nd, 1st, de luxe classes of passenger services were formally unregulated in 2003 while the first license for the private train was issued in November 2002 (Grand Express became the first private passenger train to target VIP travellers).

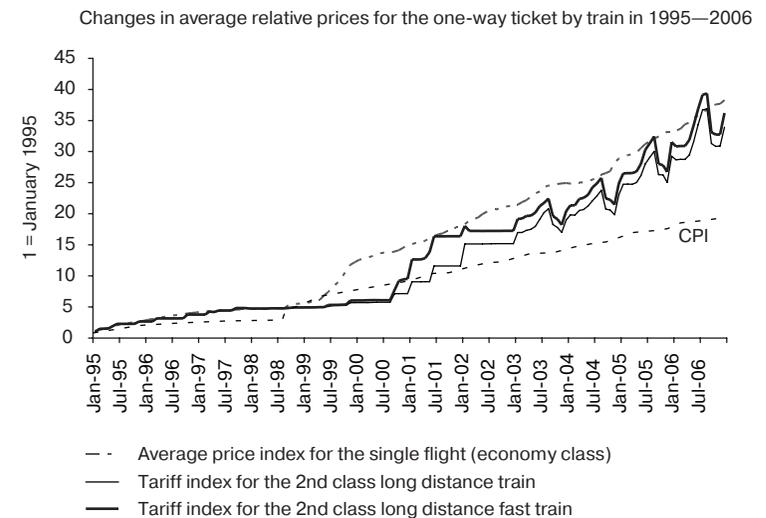


Figure 1. Relative price indices in 1995 — 2006

Scheme #3 (vertical access model with downstream deregulation) reflects the position of RZD managers and some advisors (OECD, 2007update) to retain Federal Passenger Directorate in its current status as a structural division of RZD company with very rough accounting separation.

An important point is that entry decision was preconditioned by the lack and bad quality of RZD’s wagon fleet available on the particular route. Thus in an attempt to capture the basic features of that stage of reform in Russia we incorporated some exogenously given capacity constraints exhibited by both RZD downstream affiliate and its rival(s). The presence of at least two competing operators on the particular route has always been viewed by the antimo-

nopoly authorities in Russia as a desirable outcome of the structural reform. At the same time RZD also claimed that the very presence of competing operator companies must weaken if not eliminate the regulatory pressure imposed on the RZD company. As RZD's CEO argued (Yakunin, 2007):

RZD has three strategic goals for this period. Firstly, we will develop a competitive market for transport services in co-operation with the Ministry of Transport. Secondly, we will work to increase the overall competitiveness of RZD, which means becoming much more efficient. And thirdly, RZD must increase its capitalisation while remaining under close government control.

Admitting the importance of intercity rail passenger service in Russia the ECMT/OECD team concluded their recent study of the reform progress in Russia with the following advice (OECD (2007 update), p. 24):

Experience with Amtrak and VIA in North America has shown that the fully separated approach ... has led to exactly the kinds of problems of inadequate financing, difficulty in track capacity management, poor on-time performance and unending political interference that RZD has highlighted as disadvantages of separation for the passenger railway. RZD's plans for developing a separated company or companies should take these problems into account and, at least in the near term, it may well make sense to establish the passenger company as an RZD subsidiary.

Scheme #4 (complete vertical separation with access charge set above marginal costs) means privatization of the Federal Passenger Company (FPK) making it structurally separate and institutionally independent company. Fairly curiously, the establishment of FPK as a 100% subsidiary of RZD is primarily viewed in Russia (by both the reformers and RZD managers) as a measure to speed up the process of accounting separation rather than the move to deeper disintegration between the infrastructure and passenger services.

In the following sections we compare the Scheme #3 and Scheme #4 to make judgments about their relative attractiveness primarily from the consumer's point of view. Before we proceed our formal analysis let us have a closer look at the market segment we are going to model.

The second private passenger train in Russia started its operation in 2006 on the very same route (Moscow-St. Petersburg) as the first one (Grand Express) but chose different segment, primarily 2nd class travellers (see the Figure 2 below).

The departure time of Megapolis train (00:45) is probably least comfortable among other night trains with 2nd class compartments. Its occupancy ratio is lower than that of RZD night trains. Thus the assumption that passengers first look for the tickets on RZD trains seems to be plausible.

Passenger trains capacities by class of train car (Moscow to St.Petersburg route)

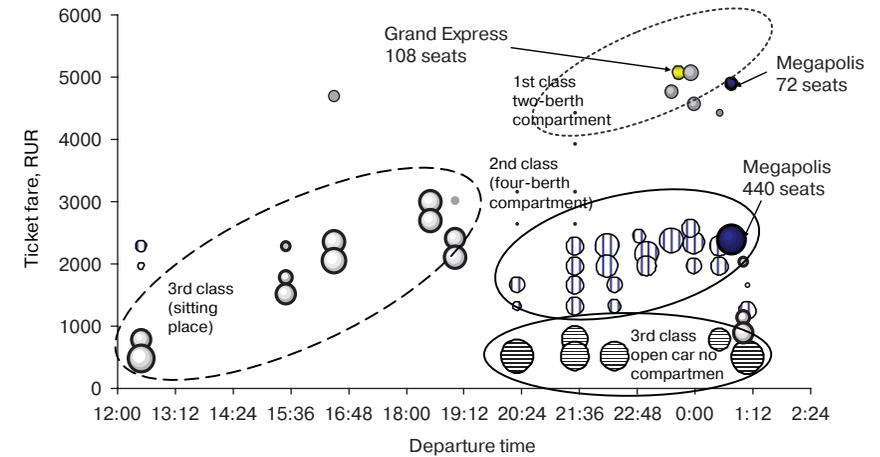


Figure 2. The size and structure of the market for intercity rail passenger service on the 'golden route' between Moscow and St. Petersburg

4. The model

The final service (2nd class passenger transportation by rail) is a homogenous good that can be supplied either by the vertically integrated incumbent or by its downstream competitors. Incumbent network owner provides access services that are required to produce final one. Entrants (or downstream competitors) supply a final service (operate wagons and charge their customers) in competition with the incumbent and use the single unit of the access service to the incumbent's network as an input (essential facility).

The upstream market size is normalized to unity. Such an assumption helps us to avoid useless calculations though allows us only to make judgments in (comparative) static terms. Nevertheless, when dealing with discrete organizational changes (as in case of structural reform) this approach proves to be fruitful. The demand for final service is completely inelastic in the short-run. There exists some finite price v that correspond to maximum willingness to pay (the best alternative way to move between the two capitals is by plane).

There are no entry barriers for the downstream market. The crucial assumption to our results is the inability by any single operator to serve all the downstream market because of its limited capacity. At the same time any two operators (incumbent's downstream affiliate, most efficient competitor and second-highest cost rival) have enough potential to supply all the market. The other possible rationale for this assumption may be the Government's structural reform measure to split the downstream capacity (wagons in our case) between the two or more operators and privatize them. So customers choose the operating company with lowest price until the latter fully utilizes all its capacity and then switch to the other one. More efficient competitors can completely displace the incumbent's final service only together. To make the model tractable we also have to assume that if several firms charge the same price for the final service, all customers prefer to purchase from the vertically integrated infrastructure owner (VIP).

The VIP can commit some sabotage s that raises his rivals' costs symmetrically by exactly this amount s . This type of discrimination is assumed to be costless for the VIP but having the upper bound \bar{s} . Thus the incumbent's discriminatory activity is limited (for instance by the counteraction of antimonopoly authority). Non-integrated rivals, on the contrary, can not exercise any level of sabotage.

The incumbent's unit cost of producing the final service is known and equal to c'_d . Its upstream unit cost is constant and equal to c_u . When the VIP supplies the downstream market, it incurs the sum of these costs less e which reflects his economies of scope (or economies of vertical integration). Thus under vertical access model the VIP's unit cost is $c_u + c'_d - e$ comparing to $c_u + c'_d$ under vertical separation.

The VIP's downstream capacity is limited by $\alpha \in [0, 1]$ the maximum share of the market which is assumed to be exogenous (when $\alpha = 1$, all the market is served by the incumbent). The rest of the market can be captured by one or another rival operator. Each rival has limited capacity equal to $(1 - \alpha)$. They can not sell it to each other or buy from the incumbent's downstream division. The entry turns out to be profitable if there is downstream production cost efficiency. But neither the most efficient competitor nor the incumbent can serve the downstream market alone.

Since the access to infrastructure is essential facility and can not be bypassed it is subject to regulation. Both Schemes #3 and #4 imply that access to infrastructure is charged by the regulator at the level $a > c_u$.

There are two downstream operators with marginal costs c^R_d and $c^R_d + \Delta$ ($\Delta \geq 0$). The smaller is Δ the greater is the toughness of competition. c^R_d is

unknown to the regulator but has density function $f(c^R_d)$ with strictly positive support on $[\underline{c}, c]$ and cumulative distribution function $F(c^R_d)$. Such an assumption reflects the idea that regulator usually makes decisions (chooses the future industry structure) before the entry occurs.

5. Discussion

To make an assessment of relative attractiveness of different structural schemes we have to consider first whether each scheme is prone to sabotage or not.

Lemma 1.

The VIP will exercise the maximum level of sabotage \bar{s} under vertical access model without downstream regulation (Scheme #3)⁸.

This result reproduces those of Sappington (2006a) derived for the Bertrand competition with no capacity constraints. The following Lemma 2 uses this finding by taking into account that strategic variable s enters the expressions for equilibrium price levels at its upper bound \bar{s} .

Lemma 2.

Under vertical access model with constrained capacities on the unregulated downstream market (Scheme #3) the Bertrand competition results in the equilibrium price being equal to the marginal costs of that player who has not entered the market:

	VIP affiliate	first efficient firm	second efficient firm	
				where
if $c^R_d \in [\hat{c} - \Delta, \bar{c}]$	$a + c^R_d + \Delta + \bar{s}$	$a + c^R_d + \Delta + \bar{s}$	-	
if $c^R_d \in [\underline{c}, \hat{c} - \Delta)$	-	$c_u + c'_d - e$	$c_u + c'_d - e$	
	$\hat{c} = c'_d - \bar{s} - e - (a - c_u)$			

The equilibrium price is unique because the market is contested by the threat of entry. Since we assumed limited capacities this price would be higher comparing to pure Bertrand case with no restrictions from the supply side. Intuitively, since the market can not be served by the most efficient competitor alone, the second efficient one enters the market bidding equilibrium price up.

⁸ The proof for this and other lemmas and propositions is provided in the Appendix.

Lemma 3.

The VIP will refrain from sabotage under vertical separation model (Scheme #4).

Lemma 4.

Under vertical separation model with constrained capacities on the unregulated downstream market (Scheme #4) the Bertrand competition results in the equilibrium price being equal to the marginal costs of the potential entrant who contests the downstream market:

	former VIP	first efficient firm	second efficient firm
if $c_D^R \in [c_D' - \Delta, \bar{c}]$	$a + c_D^R + \Delta$	$a + c_D^R + \Delta$	-
if $c_D^R \in [\underline{c}, c_D' - \Delta)$	-	$a + c_D'$	$a + c_D'$

Note that for each possible realisation of the rival's costs c_D^R neither scope economies nor sabotage parameters influence the equilibrium prices under vertical separation.

Having derived equilibrium prices for different structural schemes we now turn to the direct comparisons of the welfare effects of the reform. It is measured as the difference between the two consumers' surpluses realized under the corresponding stages of the reform. We begin with an assessment of relative attractiveness of complete vertical separation in comparison with vertical access model with no downstream regulation. Specifically, we estimate the incremental expected consumer's surplus defined as $D_{4-3} = ECS_S^4 - ECS_I^3$, where ECS_S^4 and ECS_I^3 are expected consumer's surpluses under vertical separation and vertical access models respectively.

Proposition 1.

The incremental expected consumer's surplus under vertical separation vs. vertical access with no downstream regulation (Scheme #4 vs. Scheme #3) decreases as the costs of the downstream rivals become more similar, i.e.

$$\frac{dD_{4-3}}{d\Delta} > 0$$

This proposition tells us that if inter-rival competition is sufficiently intense (relative proximity of the rivals' costs becomes more pronounced and $\Delta \rightarrow 0$) the consumer's gain from complete vertical divestiture of the VIP decreases. It means that vertical access model remains relatively more attractive comparing to vertical separation model when downstream market becomes more contestable. This result contradicts to those of Sappington (2006a) derived under the

standard assumption of Bertrand competition with no capacity constraints. Possible policy implications are discussed in the concluding section.

Proposition 2.

The incremental expected consumer's surplus under vertical separation relative to vertical access model without regulation (Scheme #4 vs. Scheme #3) decreases as the level of sabotage engaged by the VIP decreases (expected consumer's surplus under integration increases), i.e. $\frac{dD_{4-3}}{d\bar{s}} > 0$.

The natural interpretation of this proposition is the following. When regulator effectively controls the VIP's ability to exercise sabotage consumer's expected gain from the vertical separation will be less pronounced.

The following Figures 3 and 4 illustrate these findings and help to better understand the conclusions derived from Lemmas 2 and 4. The solid line demonstrates the equilibrium market price under vertical separation, while dotted line corresponds to vertical access model.

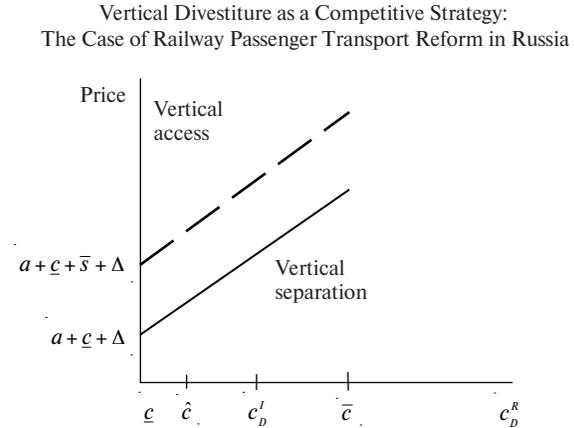


Figure 3. Equilibrium price with no inter-rival competition downstream ($\Delta > \bar{c} - \underline{c}$)

Figure 3 depicts the equilibrium price levels as a function of rival's downstream costs $c_D^R \in [\underline{c}; \bar{c}]$ under vertical access and vertical separation models, when inter-rival competition is weak. Specifically, if $\Delta > \bar{c} - \underline{c}$, the two players — the VIP affiliate and the first efficient rival — will share the market and charge its' customers the price equal to marginal costs of the second efficient rival. It is noteworthy that scope economy never passes on to consumers in the form of lower price. Intuitively, since the cost advantage of the most efficient

rival over other potential entrant is large, the latter will not enter the market. Moreover, it will make the two other players (that proved to be more cost efficient) feel quite comfortable by using the second efficient rival's costs as a ceiling for their prices. So, if the aggregate production capacity of the two players that share the market is enough to meet the total demand, there will be only moderate price competition between them. In such a case from the consumers' point of view the vertical access model (Scheme #3) is dominated by the vertical separation model (Scheme #4) since the latter guarantees lower price for each realization of c_d^R over its support.

The situation with very intense inter-rival competition is illustrated by Figure 4. When rivals' costs are quite similar (Δ is small enough to satisfy $\hat{c} < c_d^I - \Delta$ or $\Delta < c_d^I - \hat{c} = e + a + \bar{s} - c_u$) the vertical access model guarantees the lower price comparing to vertical separation model since it allows the scope economies to be passed on the consumers. The tougher is inter-rival competition ($\Delta \rightarrow 0$) the greater becomes the shaded area implying the greater attractiveness of the vertical access model. The result holds even if the access charge a is set in accordance with the marginal cost pricing principle, $a = c_u$. This is exactly what Proposition 1 tells us about.

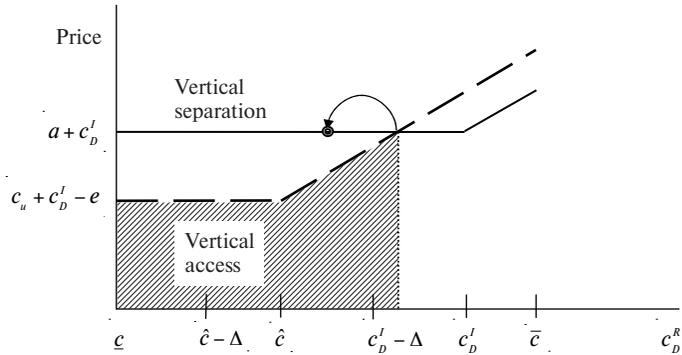


Figure 4. Equilibrium price with fierce inter-rival competition downstream ($\Delta \in [0; c_d^I - \hat{c})$)

6. Conclusions

The primary purpose of the paper was to contribute to the discussion of pros and cons of the vertical separation in the context of Russian railway passenger sector reform. The possibility of vertical divestiture of the RZD (in the form of

privatization of the Federal Passenger Company) has to be considered together with the assessment of downstream market contestability. In the context of reform strategy Proposition 1 would imply that in the presence of tough competition in the downstream market supplied by (or contested by) the unregulated RZD's subsidiary (Federal Passenger Directorate) the vertical divestiture of the latter should not be considered as a necessary precondition to guarantee higher welfare gains. In terms of reform measures this result may have the following possible interpretation: the RZD's strategy to postpone the creation of the Federal Passenger Company as an institutionally more separate (but still wholly owned) entity is worth considering together with an estimation of toughness of the downstream competition and this market contestability.

The finding postulated in Proposition 2 is quite intuitive and has a direct policy implication for the railway reform in Russia: if antimonopoly authorities can not effectively guarantee the non-discriminatory activity of the vertically integrated producer (RZD in our case), meaning that maximum level of sabotage is high, it's better to divest RZD and establish Federal Passenger Company as a separate and independent from RZD business unit.

One should be very cautious when interpreting our findings since the only welfare measure we used in the model was the consumer's surplus. More detailed analysis based on the total surplus estimation (weighted sum of consumer's and producer's surpluses) awaits further research.

Appendix

Proof of lemma 1.

When the rival operator is more efficient then the VIP the profit of the latter will be:

$$\pi^I = (a - c_u)(1 - \alpha) + \alpha(P - c_u - c_d^I + e).$$

When VIP is more efficient the market will be served firstly by the VIP. The price will equal to the marginal costs of the rival yielding the profit of

$$\pi^I = (a - c_u)(1 - \alpha) + \alpha(a + c_d^R + s - c_u - c_d^I + e).$$

Clearly, there is a positive relationship between sabotage and VIP's profit: the higher is the sabotage the higher is the profit level \Rightarrow it is optimal to exercise the maximum level of sabotage \bar{s} .

Proof of lemma 2.

When the VIP has the lowest costs in the industry is the first to serve the market.

$$1. a + c_D^R + \Delta + \bar{s} \geq a + c_D^R + \bar{s} \geq c_u + c_D^I - e \Rightarrow c_D^R \in [\underline{c}, \bar{c}]$$

The most efficient firm follows the VIP. Under Scheme #3 they both are free in setting their prices, so they will set it at the level of marginal costs of the second efficient firm $a + c_D^R + \Delta + \bar{s}$.

$$2. a + c_D^R + \Delta + \bar{s} \geq c_u + c_D^I - e > a + c_D^R + \bar{s} \Rightarrow c_D^R \in [\hat{c} - \Delta, \hat{c}]$$

Both the VIP and the first efficient firm will operate at a price $a + c_D^R + \Delta + \bar{s}$. The difference is that operator will now be the first who serves the market.

$$3. c_u + c_D^I - e \geq a + c_D^R + \Delta + \bar{s} > a + c_D^R + \bar{s} \Rightarrow c_D^R \in [\underline{c}, \hat{c} - \Delta]$$

The VIP won't operate at all. Operators will raise the price up to the marginal costs of the VIP in order to gain more profit. The price will be equal to $c_u + c_D^I - e$. QED.

Proof of lemma 3.

It is evident that under vertical separation $s=0$, since sabotage never increases equilibrium sales and therefore it never increases incumbent's profit.

Proof of lemma 4.

Under vertical separation marginal costs of the firms will be different:

$a + c_D^I$ - the former VIP's marginal costs. There are several differences with the ones under integration: first of all, there are no economies of scope e and, second, the unit price on the downstream market is now the same for all firms and is equal to:

- $a + c_D^R$ — marginal costs of the first efficient firm;
- $a + c_D^R + \Delta$ — marginal costs of the second efficient firm.

Three cases are possible:

$$1. a + c_D^R + \Delta \geq a + c_D^R \geq a + c_D^I \Rightarrow c_D^R \in [c_D^I, \bar{c}]$$

The former VIP has the lowest costs and will be the first to serve the market. The most efficient rival will follow the VIP. They both are free in setting the price, so they will set it at the level of marginal costs of the second efficient firm $a + c_D^R + \Delta$.

$$2. a + c_D^R + \Delta \geq a + c_D^I > a + c_D^R \Rightarrow c_D^R \in [c_D^I - \Delta, c_D^I]$$

Both the former VIP and the least-cost rival operator will serve the market at price $a + c_D^R + \Delta$. The competitor now serves the market first.

$$3. a + c_D^I - e \geq a + c_D^R + \Delta > a + c_D^R \Rightarrow c_D^R \in [\underline{c}, c_D^I - \Delta]$$

The former VIP will not operate at all. Independent operators will raise the price up to VIP's downstream marginal costs in order to gain more profit. The price will be equal to $a + c_D^I$. See Lemma 4 for the equilibrium prices.

Proof of proposition 1.

Expected consumer surplus under vertical separation (Scheme #4) is:

$$\begin{aligned} ECS_S^4 &= v - \int_{\underline{c}}^{\bar{c}} (a + c_D^R + \Delta) dF(c_D^R) - \int_{\hat{c}-\Delta}^{\hat{c}} (a + c_D^R + \Delta) dF(c_D^R) - \\ &- \int_{\underline{c}}^{\hat{c}-\Delta} (a + c_D^I) dF(c_D^R) = v - \int_{\hat{c}-\Delta}^{\bar{c}} (a + c_D^R + \Delta) dF(c_D^R) - \\ &- \int_{\underline{c}}^{\hat{c}-\Delta} (a + c_D^I) dF(c_D^R) = v - a - \int_{\hat{c}-\Delta}^{\bar{c}} (c_D^R + \Delta) dF(c_D^R) - \int_{\underline{c}}^{\hat{c}-\Delta} (c_D^I) dF(c_D^R) \end{aligned} \quad (2)$$

Expected consumer surplus under vertical access without regulation (Scheme #3) is:

$$\begin{aligned} ECS_I^3 &= v - \int_{\underline{c}}^{\bar{c}} (a + c_D^R + \Delta + \bar{s}) dF(c_D^R) - \\ &- \int_{\hat{c}-\Delta}^{\hat{c}} (a + c_D^R + \Delta + \bar{s}) dF(c_D^R) - \int_{\underline{c}}^{\hat{c}-\Delta} (c_u + c_D^I - e) dF(c_D^R) = \\ &= v - \int_{\hat{c}-\Delta}^{\bar{c}} (a + c_D^R + \Delta + \bar{s}) dF(c_D^R) - \int_{\underline{c}}^{\hat{c}-\Delta} (c_u + c_D^I - e) dF(c_D^R) \end{aligned} \quad (3)$$

Applying (2) and (3) we can find the difference between the two surpluses:

$$\begin{aligned} D_{4-3} &= ECS_S^4 - ECS_I^3 = v - a - \int_{\hat{c}-\Delta}^{\bar{c}} (c_D^R + \Delta) dF(c_D^R) - \\ &- \int_{\underline{c}}^{\hat{c}-\Delta} (c_D^I) dF(c_D^R) - v + \int_{\hat{c}-\Delta}^{\bar{c}} (a + c_D^R + \Delta + \bar{s}) dF(c_D^R) + \\ &+ \int_{\underline{c}}^{\hat{c}-\Delta} (c_u + c_D^I - e) dF(c_D^R) = -a - \Delta [F(\bar{c}) - F(\hat{c} - \Delta)] - \\ &- \int_{\hat{c}-\Delta}^{\bar{c}} (c_D^R) dF(c_D^R) - c_D^I [F(\hat{c} - \Delta) - F(\underline{c})] + (a + \bar{s} + \Delta) [F(\bar{c}) - F(\hat{c} - \Delta)] + \end{aligned}$$

$$\begin{aligned}
& + \int_{\hat{c}-\Delta}^{\bar{c}} (c_D^R) dF(c_D^R) + (c_u + c_D^I - e)[F(\hat{c} - \Delta) - F(\underline{c})] = \\
& = -a + (a + \bar{s})[F(\bar{c}) - F(\hat{c} - \Delta)] + (c_u - e)[F(\hat{c} - \Delta) - F(\underline{c})] = \\
& = -a + (a + \bar{s})[1 - F(\hat{c} - \Delta)] + (c_u - e)[F(\hat{c} - \Delta)] = \\
& = -a + a + \bar{s} - (a + \bar{s})[F(\hat{c} - \Delta)] + (c_u - e)[F(\hat{c} - \Delta)] = \\
& \bar{s} - (a + \bar{s})[F(\hat{c} - \Delta)] + (c_u - e)[F(\hat{c} - \Delta)] = \\
& = \bar{s} - (\bar{s} + e + a - c_u)[F(\hat{c} - \Delta)]
\end{aligned}$$

Now we can find the increment of the difference when Δ changes. This is the partial derivative of D_{4-3} with respect to Δ :

$$\frac{dD_{4-3}}{d\Delta} = (c_u - e - a - \bar{s})[f(\hat{c} - \Delta)](-1) = (a + \bar{s} + e - c_u)[f(\hat{c} - \Delta)]$$

$[f(\hat{c} - \Delta)] > 0$; $a \geq c_u$, since the incumbent supplier cannot sell the product to the retailers on the upstream market at the lower price then he has to pay himself. Therefore, $\frac{dD_{4-3}}{d\Delta} > 0$.

Proof of proposition 2.

Using the expression for D_{4-3} and differentiating it with respect to \bar{s} we get:

$$\begin{aligned}
\frac{dD_{4-3}}{d\bar{s}} & = 1 - F(\hat{c} - \Delta) + (c_u - e - a - \bar{s})[f(\hat{c} - \Delta)](-1) = \\
& = 1 - F(\hat{c} - \Delta) + (e + a + \bar{s} - c_u)[f(\hat{c} - \Delta)]
\end{aligned}$$

$$1 - F(\hat{c} - \Delta) > 0 \text{ and } e + a + \bar{s} - c_u > 0 \Rightarrow \frac{dD_{4-3}}{d\bar{s}} > 0.$$

One may also look at the effect of scale economies and differentiate D_{4-3} with respect to economies of scope e :

$$\begin{aligned}
\frac{dD_{4-3}}{de} & = -F(\hat{c} - \Delta) + (c_u - e - a - \bar{s})[f(\hat{c} - \Delta)](-1) = \\
& = -F(\hat{c} - \Delta) + (e + a + \bar{s} - c_u)[f(\hat{c} - \Delta)]
\end{aligned}$$

The sign is ambiguous, though when $F(\hat{c} - \Delta) \in [0, 1] \Rightarrow$ is sufficiently small

comparing with $(e + a + \bar{s} - c_u)[f(\hat{c} - \Delta)]$, $\frac{dD_{4-3}}{de} > 0$.

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