Organisational choice in the public sector[1]

Andrei Dementiev, Anfisa Loboyko

Higher School of Economics, Moscow

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ABSTRACT

The paper addresses the existing cross-regional diversity of delivery models in the sector of suburban passenger transportation in Russia by building a formal model of endogenous organisational choice. We develop a conceptual game-theoretic framework that allows for a trusting partnership to have become equilibrium in a regulatory bargaining game with delegation. The monopoly service provider initiates a more cooperative relationship with regional authorities by offering a share in the joint venture. The latter being benevolent welfare maximiser either accepts or rejects the offer taking into account transportation market characteristics, local budget constraints, information structure, as well as socio-economic and political factors. Once the partnership is formed the private information of the parties is revealed and information rent is eliminated creating the room for welfare improvement. However, ex ante rational organisational choice to form a trusting partnership may not lead to welfare improvement ex post. In the extended model we consider how concessionary passengers and fare-dodgers affect the bargaining outcomes. Our results can be generalized to characterize the diversity of organizational choices in the public sector.

Keywords: public-private partnership, organisational choice, delegation, suburban transport

JEL Classification: D78, H41, H72, L51, L92

1. Introduction

In many countries suburban railway transport are running on losses and are seeking alternative delivery models to lessen the subsidy burden on local governments, and Russia is not an exception. At the regional level such services have been provided by the local divisions of ‘Russian Railways’ JSC (RZD), a vertically integrated infrastructure monopoly that also serves the markets for cargo and passenger rail transportation. As tariffs are set by the local regulating authorities at a socially desirable level, passenger services traditionally experience negative operating profits. What makes the financial perspectives of railway undertakings even worse is the fact that a significant share of concessionary passengers (about

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10-30%) is only partially compensated by federal and regional budgets, not to mention a widespread fare-evasion activities (another 10-30% of patronage). Such activities are virtually unstoppable due to the fact that fines are ridiculously small, approximately the charge for a one-way ticket to zone 7.

Regional passenger service providers are regulated through a cost-based approach, meaning that the difference between reported costs and revenues from ticket sales is compensated through a lump-sum subsidy. However, when regional budgets run low, the transfer is insufficient to cover all costs. Moreover, another reason for partial compensation of reported losses is the lack of trust between the public authorities and the monopoly. In particular, by imposing strict budget constraints on the monopoly, regulators attempt to extract information rent from the asymmetry of information about costs. The underlying assumption of the binding participation constraint evidently does not work in Russia, in which cross-subsidies of loss-making passenger transport from high-margin cargo transportation fill the gap. This is an example of a specific form of indirect income redistribution from the corporate sector, which pays RZD higher infrastructure charges and tariffs for cargo transportation to the public sector where RZD reports losses.

Local authorities would automatically prefer such a state of affairs, since a public service is delivered at the expense of RZD and ultimately the corporate sector rather than regional budgets. However, this may not be socially optimal since price distortions in the corporate sector may be significant due to large mark-ups for transportation of high-value goods. Moreover, after the outright privatisation of RZD's 'first daughter', the First Cargo Company, the former (in the person of its 'second daughter', the Federal Cargo Company) faces fierce competitions in a downstream market of wagon operations. In addition, extra revenues from high-margin businesses may be taken away by independent rivals with no public service obligations. Hence, it is in the interest of RZD to change the status quo. Apparently, the two player – local authorities and RZD – seem to be engaged in a bargaining game which if played cooperatively may create room for welfare improvement.

The general strategy of passenger transportation service provisions was set by the Government, which adopted a stage-by-stage approach to railway reform on May 18, 2001. This strategy called for explicit Public Service Obligation (PSO) compensation contracts for the support of social requirements of suburban passenger transport. However, adequate sources for local budgets were never clearly defined and provided. In these circumstances RZD initiated the process of establishment Suburban Passenger Companies (SPCs) in the form of joint ventures with local authorities. Essentially, RZD offered local authorities a share in the charter capital of newly created companies, thus proposing a specific form trusting partnership (see Stanley and Hensher, 2008 for the definition). This form of cooperation has been proposed by RZD as an optional alternative delivery model in the sector. Consequently, local authorities were free to engage in a trusting partnership depending on transportation market characteristics, local budget constraints, information structure, as well as socio-economic and political factors of a specific region.

According to a sociological survey conducted by the Higher School of Economics in 2010, local authorities had low incentives in participating in the suburban railway transport reform. Among 65 surveyed regions 17 (26%) reported that they were not involved in the reform and 28 (43%) intended to play a passive role. Only 8 (12%) regions saw themselves as active participants of the reform and 12 (19%) regions were likely to be involved with some reservations. Different factors across 73 Russian regions affected the reform pace, such as geographic and socio-economic conditions as well as political and local cultural contexts. The observed variety of shareholding structures of 28 existing SPCs (see Table 1) provides the relevant factual background and poses a number of questions: Why did some regional authorities have agreed to partner with the service provider while other not? Will trusting partnerships lead to welfare improvement? What is the right share in a trusting partnership in order to be accepted? What factors affect the probability of creating a trusting partnership and how?

Table 1: The share structure of suburban passenger companies (SPCs) in Russia

No.	Est.	Company name	Share Structure, %		
			RZD	Region 1	Region 2
1	1998	Express-Prigorod	51	46	3
2	2003	Kuzbass-Prigorod	51	49	
3	2003	Omsk-Prigorod	51	49	
4	2003	Altay-Prigorod	51	49	
5	2005	Central SPC	49,34	25,33 (Moscow City)	25,33 (Moscow region)
6	2005	Krasprigorod	51	49	
7	2005	Express Primoriya	51	49	
8	2005	Sverdlovskaya SPC	51	49	
9	2005	Aeroexpress	50	25 (JSC"DeltaTrans-Invest")	25 Private investors
10	2006	Nord-West SPC	74	26	
11	2006	Volgogradtransprigorod	51	49	
12	2006	Severo-Kavkazskaya SPC	74	26	
13	2009	Sodruzhestvo	49,33	25,33	25,33
14	2009	Volgo-Vyatskaya SPC	49,33	25,33	25,33
15	2009	Permskaya SPC	51	49	
16	2009	Moscovsko-Tverskaya SPC	49,33	25,33	25,33 (JSC "Delta-Trans-Invest")
17	2010	Bashkortostanskaya SPC	99,17	0,87	
18	2010	Samaraskaya SPC	49	51	
19	2010	Kuban Express-Prigorod	49	51	
20	2010	Permskyy Express	0	100	
21	2010	SPC «Chernozemie»	50,5	25,5 (Voronezh region)	5 (Lipetsk region) 10 (Tambov region) 9 (Belgorod region)
22	2010	North SPC	100		
23	2011	SPC «Sakhalin»	99	1	
24	2011	Zabaikalskaya SPC	51	49	
25	2011	Yuzhno-Uralskaya SPC	99	1	
26	2011	Baikalskaya SPC	50,01	49,99	
27	2011	Saratovskaya SPC	51	49	
28	2011	Kaliningradskaya SPC	99	1	

Source: RZD

This paper addresses the existing cross-regional diversity of delivery models in the sector of suburban passenger transportation in Russia by building a formal model of endogenous organisational choice. We develop a conceptual game-theoretic framework that enables the trusting partnership to have become equilibrium in a bargaining game rather than a predetermined outcome.

The building blocks of our model are as follows. First, a standard regulator's objective function puts a lower weight on the firm's profit, reflecting certain redistribution concerns of the government. Second, we impose budget constraint on the local government and assume it to be binding, reflecting the case where a lack of public funds affects organizational choice in the sector. By further introducing information asymmetry of the firm's costs, we create room for bargaining between the firm and the regulator. In the end, we define the conditions for trusting arrangements to become equilibrium in the bargaining game mentioned above.

Regarding the tractability of the model, we use a number of simplifying assumptions, such as linear demand function and constant unit cost of services. In the basic model, the service provider is assumed to have confidential information about the costs. It proposes to establish a trusting partnership with local authorities to share this information in exchange for greater representation of its interest in future partnerships. Thus information structure of the regulatory game ex ante and ex post plays a crucial role in our analysis.

The rest of the paper is structured as follows. Section 2 provides a brief literature review and highlights the importance of developing an analytical framework specific for the questions of interest. Section 3 identifies relevant parties of the game, their objectives, choice variables and payoffs for the two different delivery models. Section 4 discusses two interesting extensions - the case of concessionary passengers and fare-dodgers. Section 5 makes a summary of this paper.

2. Literature review

This proposed model has been inspired by several seemingly unrelated streams of studies. We incorporate the idea of 'selling authority' from Lim (2012) into the standard regulatory framework of Armstrong and Sappington (2006), which emphasize the role of imperfect information in a regulatory game. We modify this approach by establishing trusting partnerships as an organisational alternative that will ultimately reshape the political and institutional environment of the standard regulatory game. In particular, similar to Laffont (1999, 2000) we understand trusting partnerships as a better-informed decision maker with specific objective functions. With this option, regulator as a benevolent social welfare maximiser can choose whether or not to delegate the contracting process to the trusting partnerships, including tariff setting.

Bennett and Iossa (2006b) consider the idea of delegated contracting by treating the public-private partnership (PPP) as a joint venture between the private sector (service provider) and a public sector. Compared to a public sector entity, the PPP is more orientated towards profit-making than social benefit. Their analysis suggests that the weight placed by the PPP on social benefits is a critical factor to the success of contracting delegation. The authors point out that the formation of a corporate share structure of the PPP should be a matter of particular concern, while the existing approach to modelling PPP[2] pays little attention to the process of ex ante bargaining over its structure. We depart from this literature by making the delegation process endogenous and developing a specific framework in the realm of political economy for the analysis of partnerships creation in the Russian context.

Our approach can be generalized for studies of political feasibility of institutional reform in public sector (see Boardman and Vining, 2012 for the discussion of political economy perspective on PPPs and Chong et al., 2006 for the empirical study of the endogenous nature of organisational choice). According to Maskin and Tirole (2008), there is substantial evidence that the desire to please constituencies and budgetary constraints have significantly influences on political project choices. We believe that our model provides a tractable way to see the role of redistribution concerns and budget limits in organisational choices. The underlying assumptions are, first, that the private partner does not capture the procurement process by colluding with the government and second, that government retains its benevolence[3].

[2] Bennett and Iossa (2006a), Martimort and Pouyet (2008), Carmona (2010), Iossa and Martimort (2012) etc. are examples.
[3] See Laffont and Martimort(1999), Martimort (1999) for the case of non-benevolent or captured government agencies.

Practical developments of trusting partnerships in public transport have run ahead of academic analysis. Stanley and Hensher (2008) summarize a number of prerequisites for successful partnering in the sector, such as common objectives of the parties, agreed governance arrangements and risk-sharing rules (see also Medda, 2007 and Sock-Yong Phang, 2007), relationship management, trust, transparency and accountability. This insight is incorporated in the proposed model below.

3. The model

In this section we describe the basic regulatory model which is subject to further modification and extension. As a benchmark and a basis for welfare comparison, we use the case of the status quo in which local authorities (the regulator) are obliged to undertake a public service project (suburban transportation by rail) for its social benefits. The regulator can employ two delivery models: 1) centralised contracting in the form of a Public Service Obligation (PSO) in which a monopoly service provider is regulated through tariffs and lump-sum transfers, and 2) delegated contracting in which tariff setting is determined by a joint venture of the public and private sectors. The joint venture is established voluntarily in the form of a trusting partnership with an objective to maximize a linear combination of social welfare and profit.

3.1 Public Service Obligation

3.1.1 Agents' objectives and choice variables

PSO is modelled as a regulated contract for transport service provision. The monopoly service provider is obligated to serve all customers at the regulated unit price, P. The demand curve for the single homogenous product is common knowledge and assumed to be linear: $Q(P) = a - bP$. The firm is assumed to incur unit cost of production θ and no fixed cost[4]. The regulator sets both unit price, P, and determines a lump-sum transfer payment, T_{RS}, from taxpayers to the firm.

The firm maximises its profit $\pi = Q(P) \cdot [P - \theta] + T_{RS}$ while the benevolent regulator pursues the goal of maximizing the expected value of social welfare, $W = V(P) - [1 + \lambda]T_{RS} + \alpha\pi$. $V(P)$ denotes consumer surplus, which is reduced by the transfer payment $[1 + \lambda]T_{RS}$ estimated at the social cost of public funds, $\lambda \geq 0$. Regulators often have implicit distributional concerns and value the consumer surplus more than the producer surplus, i.e. $\alpha \leq 1$. This parameter plays a crucial role in our further analysis.

3.1.2 Hard budget and soft participation constraints

The benevolent regulator as the social welfare maximiser may set unit price P below cost if it values consumer welfare to the greater extent as corporate sector profit. Therefore the tariff setting and transfer payment provision implies a certain policy of redistribution between transport end-users, taxpayers, and the firm's shareholders. Since political and socio-economic factors affect the policymakers' preferences in redistribution, the ownership structure of the service provider becomes a significant issue. In fact, the firm may operate on losses when α is relatively low. Compensation of these losses may not be feasible when transfer T_{RS} is restricted by the *hard budget constraint*, $T_{RS} \leq T$, where local budget limit T is assumed to be exogenous at the regional level.

Operation on losses violates the standard participation constraint of the regulated firm. However, in certain institutional environments, the regulated monopoly may not escape from providing the service –

[4] The assumption of no fixed cost is common to the literature on optimal regulation. Moreover, existing regulatory stimulus in the passenger railway transport in Russia allows Suburban Passenger Companies to pay symbolic 1% of the infrastructure access charge and save up to 50% of their total cost. Thus the assumption of fixed costs to be virtually zero is also relevant for the case studied.

the winner's curse is an example. Another example of so-called *soft participation constraint* would be the case of a multiproduct monopoly being regulated separately in different markets. For instance, loss-making passenger transportation in Russia is cross-subsidised by the high-margin cargo transportation. This is also an illustration of a specific form of indirect income redistribution from the corporate sector to the public one. In particular, cargo shipper pay RZD higher infrastructure charges and transportation tariffs while in the passenger markets RZD reports losses.

In these circumstances, local authorities may suffer from budget centralisation and a short of funds, and therefore unable to fully compensate the cost of service provision at a regional level. However, at the federal level, RZD is regulated in such a way as to secure overall profitability. RZD's operating profit net of subsidies from federal and municipal budgets decreased from 102.1 bln ruble in 2012 to 72.0 bln ruble in 2013, but nonetheless remains significantly positive. Effectively, RZD benefits from *de facto* implementation of the Ramsey pricing principle for infrastructure access charge in Russia. However, this paper does not intend to discussion the optimality of such an approach to tariff regulation. What matters is that regional passenger divisions of RZD, being the monopoly service providers in the local transportation markets, can operate on systemic losses covered from corporate sources rather than public funds. Thus we make the following assumptions.

Assumption 1. For the multiproduct monopoly regulated in separate markets, participation constraint in a single market may not be binding, so the firm may operate with losses.

Assumption 2. Lump-sum transfer, T_{RS}, from the regulator to the firm is insufficient to fully compensate for the firm's operating losses so the hard budget constraint $T_{RS} \leq T$ becomes binding.

A starting point for a further analysis is the case where unit cost of production θ is known. Subsequently, we relax this assumption and directly compare the welfare in case of complete and asymmetric information.

3.1.3 Payoffs under complete information

When Assumptions 1 and 2 hold, the welfare optimisation problem of the benevolent regulator can be written as:

$$
\begin{aligned}
&W = V(P) - [1+\lambda]T_{RS} + \alpha[Q(P)\cdot[P-\theta] + T_{RS}] \xrightarrow{P\geq 0} \max \\
&\qquad s.t.\, T_{RS} \leq T
\end{aligned}
$$

Socially optimal tariff $P = (a - \alpha b\theta - \alpha a)/b(1-2\alpha)$ is positive when $\alpha > 1/2$ (see the proof of this and other formulas in the Appendix). When the relative weight of the producer surplus in the social welfare function is too low, the regulator effectively defends the interest of consumers who always seek a 'free-lunch'. Indeed, one can prove that Lemma 1 holds:

Lemma 1: In a complete information framework, socially optimal tariff increases with the relative weight put on the producer's surplus in the social welfare function, i.e. $\partial P/\partial \alpha > 0$.

Still, if it is below the marginal cost and the lump-sum transfer from the budget is insufficient to compensate for the negative margin, a positive tariff does not guarantee that the firm will breakeven. The regulator's preferences for redistribution make it optimal to set the tariff at the level below one that is economically sound in order to maximise social welfare. Thus, Lemma 2 holds:

Lemma 2: When $1/2 < \alpha < 1$ the socially optimal tariff is set at the level below marginal cost, $0 < P < \theta$.

Once tariff revenues are insufficient to fully cover all the costs incurred, it is vital for the regulated firm to be adequately compensated through the mechanism of lump-sum transfer. When local budgets lack funds, the regulated firm operates on a loss (see Eq. (A.1) in the Appendix), so Assumptions 1 and 2 are fully justified in the case of complete information.

A closed form solution can be useful for the welfare function in the case of a PSO, with complete information as a criterion for a comparison of social welfare among different organisational alternatives. When the budget constraint becomes binding and the lump-sum transfer from the regulator to the firm amounts at the budget cap, T, the social welfare under public service obligation looks as follows:

$$W^{PSO} = V(P) - [1+\lambda]T + \alpha\pi = -\alpha^2 (a - b\theta)^2 / 2b(1-2\alpha) - (1+\lambda-\alpha)T \tag{1}$$

The analysis of the PSO case with full information shows that the relative size of the redistribution parameter α and the shadow cost of public funds λ have a direct welfare implication. In particular, when welfare losses caused by distortionary taxation pose a serious problem for the economy (λ is high), and redistribution concerns are very pronounced (α is low), condition $\lambda > \alpha$ is likely to hold, meaning that compensatory transfers from the local budgets to the firm are not desirable from a social perspective.

3.1.4 Payoffs under asymmetric information

When cost can not be directly observed by the regulator, though the density function $f(\theta)$ at the support $[\underline{\theta}, \overline{\theta}]$ is known, the regulator's problem leads to the same solution for the optimal tariff in expected terms: $P = (a - \alpha bE\theta - \alpha a)/b(1-2\alpha)$, where the cost parameter, θ, is substituted by its expected value: $E\theta \equiv \int_{\underline{\theta}}^{\overline{\theta}} \theta f(\theta) d\theta$.

Again, optimal tariff can be set at the level below marginal cost, $0 < P < \theta$, when the relative weight of profit in the welfare function is larger than that of consumers: $1/2 < \alpha < 1 - \dfrac{b(E\theta - \theta)}{a - b\theta + b(E\theta - \theta)}$ (see Eq. (A.2)).

Theoretically, when the regulator is poorly informed of the firm's actual cost parameter θ, the optimal tariff for the purpose of social welfare maximization may turn out to be too high. In the context of very efficient firm, when revealed cost is below its expected level, $\theta < E\theta$, the tariff may exceed its monopolistic level: $\theta < \dfrac{a - 2\alpha bE\theta}{b(1-2\alpha)}$ (see Eq.(A.3)). Hence, a cost-efficient firm benefits from revealing its cost to the regulator.

Generally speaking, asymmetric information creates distortions which lead to lower social welfare, W_0^{PSO}. Once such an asymmetry is mitigated (as in the case of trusting partnership) the firm's profit and social welfare can be improved:

$$\pi_0^{PSO} = \pi^{PSO} - \left(\alpha(a-b\theta)(\theta - E\theta) + \alpha^2 b(\theta - E\theta)^2\right)/(1-2\alpha)^2 \tag{2}$$

$$W_0^{PSO} = W^{PSO} + \alpha^2 b(\theta - E\theta)^2 / 2(1-2\alpha) < W^{PSO} \tag{3}$$

The expressions (2) for profit and (3) for the welfare function are identical to the case of complete information subject to θ substituted by its expected value, $E\theta$.

3.2 Trusting Partnership

3.2.1 Agents, their objectives and choice variables

Trusting partnerships arise when public and private agents agree to delegate the decision-making process to an entity with a specific corporate structure that reflects both the regulator's benevolent objective function and the firm's profit. Bennett and Iossa (2006b) develop this idea in the context of public-private partnership, so we use the notation PPP for trusting partnerships hereinafter. The objective function of a trusting partnership, U_{PPP} , is a linear combination of social welfare and monopoly profit: $U_{PPP} = \omega W + (1-\omega)\pi$, where ω represents the relative weight of the regulator's interest in the partnership's composite objective function. These weights reflect the share structure of the joint venture that the regulator may agree to establish based on the initiative of the service provider. The firm's profit maximisation problem remains unaffected in the absence of a profit distribution concerns or a rule of dividend sharing.

3.2.2 Payoffs under trusting partnership

We consider a 'regulatory bargaining game with a delegation' with the following timing of the negotiation process. First, the firm makes an offer regarding ω; second, the regulator decides whether to accept or reject the offer. If the offer is accepted, a trusting partnership is formed (thus greater weight is placed on the firm's profit) and information about cost is revealed. Finally, tariff is determined according to the new weights in the joint objective function. If the offer to form the trusting partnership is rejected, tariff setting is not delegated to it, so regulator's objective function remains intact while information about the firm's cost is undisclosed. Other things being equal, social welfare decreases with ω, while elimination of information asymmetry (as shown in formula (3)) proves to be ex ante welfare improving. Thus, there exists a non-empty set of possible values of ω , $\omega \in [\underline{\omega},1]$, when the partnership establishment is ex ante perceived by the regulator as social welfare improving, hence the firm's offer is accepted.

A relatively cost efficient firm has incentive to offer a greater share in a trusting partnership since it has to sacrifice its profit once its cost parameter is revealed. There is thus a range of possible levels of ω, $\omega \in [0,\overline{\omega}]$, when the firm is worse off as a result of a trusting partnership. Consequently, the offer can either be withdrawn or rejected by the regulator, so the status quo is retained. Relatively inefficient firms always benefit from the elimination of information asymmetry and would always offer a positive share in a trusting partnership to regulator.

Naturally, a partnership's objective function represents the monotonic transformation of the regulator's objective function where the relative weight of the firm's profit, α , is replaced by the new weight, $\psi = (1-\omega(1-\alpha))/\omega = \alpha + ((1/\omega)-1)$. Hence, the expression for the optimal tariff can be written by plugging $\psi \geq \alpha$ instead of α in the previous formula: $P = (a - \psi(b\theta + a))/(b - 2\psi b)$. The firm's profit under a trusting partnership arrangement, $\pi_{PPP} = -\psi(a-b\theta)^2(1-\psi)/b(1-2\psi)^2 + T$, decreases with ω, so $\partial\pi_{PPP}/\partial\omega < 0$ (see Eq.(A.5)). Thus the firm would offer the lowest possible share ω in the partnership that is accepted by the regulator. Ultimately, the formation of a partnership depends on the decision of the regulator.

3.3 The regulator's choice

The timing of the model implies that the firm's offer to establish a partnership is considered by the regulator prior to information disclosure. Elimination of information asymmetry would increase social welfare, since $EW(P(\theta)) > W(P(E\theta))$. The scope of information asymmetry is measured by the standard deviation of the unit cost, σ_θ. It's important to emphasize here that the regulator makes the organisational choice dealing with the expected values when comparing the social welfare function under asymmetric information (W_0^{PSO}) with the expected welfare function under a partnership (EU^{PPP}):

$$W_0^{PSO} = \frac{-\alpha^2(a-bE\theta)^2}{2b(1-2\alpha)} - (1+\lambda-\alpha)T \vee \omega\left(\frac{-\psi^2\left[b^2\sigma_\theta^2 + (a-bE\theta)^2\right]}{2b(1-2\psi)} - (1+\lambda-\psi)T\right) = EU_{PPP}$$

In order to study the welfare implications of trusting partnership, one should compare the benchmark case for the actual social welfare under complete information before the establishment of a partnership (W^{PSO}) and social welfare under complete information after the establishment of a trusting partnership (U^{PPP}):

$$W^{PSO} = \frac{-\alpha^2(a-b\theta)^2}{2b(1-2\alpha)} - (1+\lambda-\alpha)T + \frac{\alpha^2 b(\theta-E\theta)^2}{2(1-2\alpha)} \vee \omega\left(\frac{-\psi^2(a-b\theta)^2}{2b(1-2\psi)} - (1+\lambda-\psi)T\right) = U_{PPP}.$$

4. Extensions

4.1 Concessionary passengers

Concessionary passengers are those who are entitled to social privileges and pay lower charge for travel. Without loss of generality, we can normalise this charge to zero thus assuming that by providing service to this group the monopoly receives no revenue from ticket sales and has to be compensated by lump-sum transfer from the budget. The previously studied transfer T_{RS} is also normalized to zero since it does not have qualitative implications. The focus here is on the transfer from the local budget to compensate the service cost caused only by concessionary passengers. Initially, we assume that public funds are always available for this purpose, and further we relax this assumption and introduce a budget limit unknown ex ante to the firm.

4.1.1 Public service obligation

We denote the number of concessionary passengers who travel for free by $\tilde{a}$. They derive a certain utility U_{CP} which in the absence of externalities is simply added to the social welfare function. Though the regulator may be perfectly aware of the maximum number of passengers with the legal right to travel for free, it is the firm that has confidential information about actual demand parameter $\tilde{a}$. So the regulator compensates the cost incurred by the service provider on the basis of expected demand $E\tilde{a}$ and pays a corresponding budget transfer $T = \theta E\tilde{a}$ to the firm. The aggregate social welfare function becomes $W = CS(P) + U_{CP} - [1+\lambda]T + \alpha[\pi(P) + T]$, where $CS(P)$ is a consumer surplus of the regular passengers[5]. In fact, we consider the situation when the only source of information asymmetry is $\tilde{a}$, while unit cost of the firm θ is known to the regulator. Socially optimal tariff thus would be the same as in the benchmark case $P = (a - \alpha b\theta - \alpha a)/b(1-2\alpha)$ while social welfare function is altered:

[5] We avoid here the problem of optimal tariff regulation under incomplete information because the utility of concessionary passengers is assumed to be additively separable and does not enter FOC.

$$W = \left[\frac{(a - bP)^2}{2b} + U_{CP} + \alpha\big((P - \theta)(a - bP) - \theta\tilde{a}\big) \right] - (1 + \lambda - \alpha)\theta E\tilde{a}$$

The expected number of concessionary passengers defines the transfer but not the tariff. Evidently, due to social cost of public funds and lower relative weight on producer surplus, the society benefits from the lower transfer from the budget based on the total number of concessionary passenger. When the firm is obligated to deliver this public service the local authorities have incentives to minimise financial support of the sector causing unsustainable situation.

4.1.2 Trusting partnership

As in the benchmark case, the delegation of tariff setting to a trusting partnership results in tariff increase on the one hand and information rent elimination on the other hand. The total effect of the establishment of trusting partnership on social welfare is thus ambiguous. The transfer is determined prior to the partnership establishment and may be constrained by the availability of public funds. Once the actual number of concessionary passengers is revealed, the firm obtains the transfer $\theta\tilde{a}$. The level of expected transfer is based on this number and equals to $ET = E(\theta\tilde{a}) = \theta E\tilde{a}$. But the actual transfer is assumed to be always within the exogenously given budget limit A which may or may not be binding. Thus we consider two cases.

Case 1: Under no budget constraint for compensation of concessionary transportation, social welfare is unaffected by the elimination of information asymmetry. (see Appendix for the proof). Thus, the regulator would never agree to form a trusting partnership and hence set suboptimal levels of tariff in this case.

Case 2: When the budget for compensation of concessions is limited to an exogenous level A, and the number of concessionary passengers is random variable on the support $[\tilde{a}_{LOW}, \tilde{a}_{HIGH}]$ with known density function $g(\tilde{a})$.

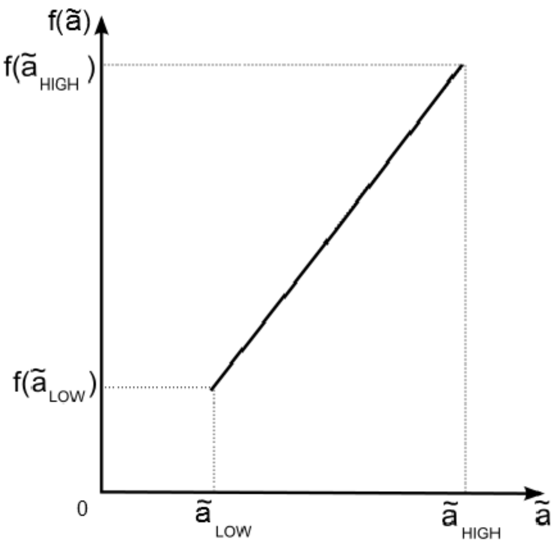

Fig. 1 (a). The transfer as a function of the number of concessionary passengers with no budget limits

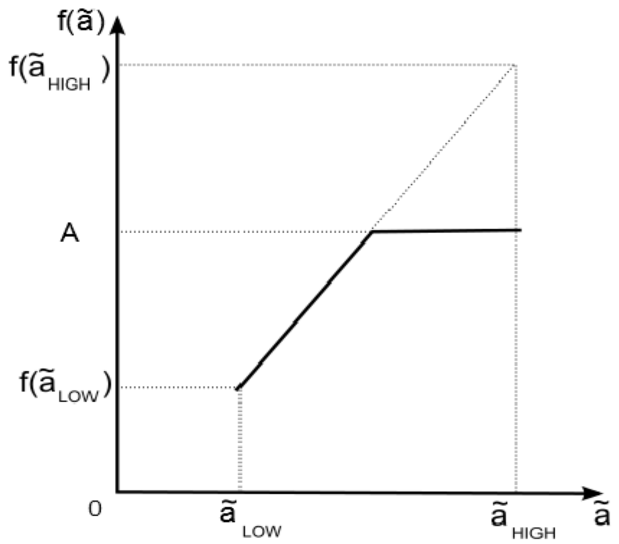

Fig. 1 (b). The transfer as a function of the number of concessionary passengers with budget limit $A < \theta\tilde{a}_{HIGH}$

In Case 2, the transfer based on the expected number of concessionary passengers is higher than the expected transfer based on the actual number. Indeed, transfer represents a concave function of the number of concessionary passengers (Fig 1(b)). This means that the partnership establishment is associated with expected reduction in transfer. Yet, as shown above, the lower is the transfer; the higher is the social welfare. Thus, the regulator is more likely to agree on a partnership establishment for the expected positive welfare effect of information rent elimination. This effect is expected to be positive whatever the proposed ownership structure. There must exist a non-empty set of possible values of, $\omega \in [\underline{\omega}, 1]$, under which the regulator perceives a partnership establishment as social welfare improving. Hence, when budget constraint is binding (as in Case 2), there exists room for endogenous establishment of a trusting partnership.

There are two effects of trusting partnership establishment on the firm as well. One arises from the delegation of tariff setting to the agent who places greater relative weight on producer surplus than the regulator. It affects the firm's profit positively, as shown in Section 3. When the actual number of concessionary passengers is higher than what is compensated by the regulator under PSO, the firm is worse off from the elimination of information asymmetry. Thus the firm would wish to offer a certain share in a partnership ω, $\omega \in [0, \overline{\omega}]$ to offset the loss. The set of possible shares in a partnership could also be empty, and the firm makes no offer to the regulator in this case. When the actual number of concessionary passengers is lower, the firm benefits from the information rent elimination and is indifferent about the share structure of a partnership once it is established.

The role of hard budget constraint is considered in the setup when the budget limit A is not known to the service provider a priori. If A is overestimated, the firm would miss the opportunity to offer a higher share in a partnership that would secure maximum profit. If A is underestimated, the offer to form a partnership may be rejected by the regulator. Thus we can formulate the following propositions.

Proposition 1: Uncertain demand of concessionary transportation makes the organisational choice of trusting partnership less likely.

Proposition 2: Tougher budget constraint for compensation of concessionary passengers makes the organisational choice of trusting partnership more likely.

We discuss implications of the two propositions in the concluding section of the paper.

4.2 Fare-dodgers

An additional factor that supports the development of trusting partnerships even in the absence of information asymmetry is the scope of fare evasion. For the illustrative purposes we now make the assumption of linear total demand for the service comprising of the demand of obedient passengers $Q_{OP}(P) = a_1 - b_1 P$, and the demand of free-rider $Q_{FR}(P) = a_2 + b_2 P$, where $a_1, a_2, b_1, b_2 > 0$. The former is a usual downward-sloping function, while the latter is an upward-sloping one reflecting positive relationship between the tariff and the number of free-riders. The assumption $b_1 > b_2$ captures the idea that demand of obedient passengers decreases in tariff, since part of the passengers become free riders and another part switch to other means of transport. Consequently, the overall demand for the service is downward-sloping yet steeper than the demand of obedient passengers alone: $Q(P) = (a_1 + a_2) - (b_1 - b_2)P$.

4.2.1 Public services obligation

The existence of free riders affects social welfare in two ways. On the one hand, it decreases producer surplus since the firm collects no ticket revenues from them. On the other hand, it increases consumer surplus due to higher patronage. The optimal tariff in the absence of information asymmetry would be: $P = \dfrac{-(a_1 + a_2) + \alpha(a_1 + \theta(b_1 - b_2))}{-(b_1 - b_2) + 2\alpha b_1}$.

The problem of fare evasion is particularly severe in Russia, where about 10-30% of passengers constantly do not pay for their travel (see Table 2). Ironically, RZD as a commercial firm has no right to penalise fare dodgers according to existing legislation, and only the local authorities are entitled to collect fines. Moreover, as Dementiev & Zaitseva (2013) study on social capital in suburban railway transport in Russia reveals, fare-evasion in Russia does not vary to the amount of fines or on-route ticket inspection intensity. In fact, the only effective measure to force passengers to pay for their journeys proves to be an access prevention measure such as tourniquets.

Table 2. The scope of fare-evasion in suburban railway transport sector in Russia

Suburban Passenger Company	Estimated percentage of fare-dodgers, (data)	Average monthly wage (RUR) in Russian regions in 2010
Sverdlovskaya	3 (09. 2012)	19 674,7
Yuzhno-Uralskaya	7 – 13 (09. 2012)	17 388,4
Moskovsko-Tverskaya	22 (10. 2012)	25 502,1
Central	10 – 30 (05. 2012)	40 479,2
Nord-West	15 – 35 (03.2012)	27 618,1
Saratovskaya	15 – 25 (06. 2012)	14 592,3
North	5 – 7 (09. 2012)	21 263,3

Source: Federal State Statistics Service

That is, the problem of fare-evasion in Russia requires complex and costly solution and hardly can be tackled with incremental policy innovations, such as greater number of ticket inspectors or on route higher fines. as a precondition for establishment of a trusting partnership (other things being equal), Thus we introduce a certain threshold control variable, F as a fixed investment in enforcement technologies such as tourniquets. So we assume that if F is sufficiently large, free riders are completely blocked from the service. Hence, the optimal tariff can be raised to at least partially compensate for the sunk investment disbursed:

$P = \dfrac{-(a_1 + a_2) + \alpha((a_1 + a_2) + \theta(b_1 - b_2))}{-(b_1 - b_2) + 2\alpha(b_1 - b_2)}$ (see the proof in the Appendix).

In the absence of this sunk cost from blocking free riders from the service, the society would certainly be better off. Indeed, it is in the power of the regulator to leave the tariff unchanged, and with the fixed tariff, the only change to social welfare would be an increase in revenue of the service provider when fare dodgers start paying. The regulator could only be motivated to change the tariff by further improvement in social welfare. Indeed, the regulator may decide not to block free-riders if the social cost of public funds required for this investment is higher than the an increase in social welfare: $0 < \Delta CS + \alpha \Delta PS < (1 + \lambda)F$.

4.2.2 Trusting partnership

If investment in enforcing technology is made by the firm rather than the public authority, the society may benefit as a whole. In particular, if the shadow cost of public funds is large, the following condition holds: $\alpha F < (1+\lambda)F$. Yet, the socially optimal tariff would remain the same as FOC is unaffected. We claim that the establishment of a partnership provides a necessary incentive for the firm to incur such a fixed cost if it is compensated through higher tariff.

Proposition 3: Under symmetric information, social welfare decreases with the share of service provider in a trusting partnership.

If decision-making is delegated to an agent whose objectives differ from the social welfare maximization criteria, a higher proposed share of the service provider in the partnership will lead to a greater negative effect of its establishment on social welfare. Hence, there exists a non-empty set of possible values of $\omega \in [\underline{\omega}, 1]$, under which the regulator perceives the establishment of a trusting partnership as improving social welfare.

Notably, it may be beneficial for the firm to incur some fixed cost of blocking free-riders even in the absence of a trusting partnership. Indeed when the social welfare function puts lower weight on producer surplus, the change in social welfare is smaller than the increase in the firm's profit after deducting the fixed cost: $\Delta SW = \Delta CS + \alpha \Delta PS - (1+\lambda)F < \Delta PS - F = \Delta \pi$. In fact, as soon as the regulator finds it socially optimal to block free-riders from the service, it is also beneficial for the firm to incur such fixed cost even in the absence of a trusting partnership. Consequently, the firm would seize every opportunity to propose a trusting partnership to increase its profit even further. Naturally, in absence of information asymmetry, every offer made by the firm will be accepted by the regulator.

5. Discussion and conclusions

The concept of public service obligation is widely used in railway transportation services, and is applicable to both profitable and unprofitable services. In the case of defaulting local governments, unfunded obligations would undermine the services. When a socially desirable tariff is set at a level below an economically optimal one and subsidies from the local budgets are insufficient to cover all the losses, any revenue maximising firm would avoid participating in public service provision. So, an economically optimal PSO contract becomes politically unfeasible. However, as the Russian railway reform shows, the very status of RZD being a profitable multiproduct monopoly prompts the local authorities to favour the company in meeting the pricing and demand obligations through internal cross subsidy. From an economic point of view, this argument is not convincing since implicit redistribution from one customer (freight shippers) to another (passengers) may cause net loss in efficiency. Neither is it satisfactory from the RZD's commercial perspective. This landscape of political economy is a starting point for our game-theoretic framework which develops a formal model of how local cash-strapped governments may wish to choose trusting partnership as a delivery model, which is initially proposed by the regulated service provider.

The establishment of Suburban Passenger Companies (SPCs) in the form of trusting partnerships between local authorities and regional divisions of Russian Railways has become an alternative to vaguely determined and weakly enforced PSO compensation contracts for suburban operations. These delivery models vary across Russian regions in terms of the share of operator losses that Federal and local governments de facto compensate for (see Table 3) as well as the ownership structure of SPCs which has been gradually changing for the last 15 years in Russia (see Table 1).

Table 3. Compensation of losses from suburban railway passenger services in the Russian regions

The scope of compensation from the local budges	**Number of regions (73 in total)**		
	2011	2012	2013
No compensation required	6	5	6
100% compensated	16	16	6
>50% compensated	13	14	21
<50% compensated	34	34	37
No budget for compensation	4	4	3

Source: Federal State Statistics Service

Our paper develops a conceptual framework for the analysis of the establishment of trusting partnerships in the form of PPP in Russia's suburban railway passenger sector. We contribute to the existing literature on PPP by making an organisational choice endogenous in the sense that local authorities are free to accept or reject the offer to partner with the regulated service provider. This modelling approach differs from the story of regulatory capture, because tariff setting is delegated to a third agent (a partnership) that has no private interest. In essence, trusting partnership is viewed as a specific institutional arrangement that aims to maximize the composite objective function to determine tariff and reveals the firm's hidden characteristics based on the trusting relationships within PPP. Setting optimal tariff with hidden information of the firm's cost becomes a subgame of the 'regulatory bargaining game with delegation'. In particular, under certain conditions benevolent local authorities may find that a switch from Public Service Obligation delivery model to PPP will improve social welfare. In other words, the organisational choice is made first, then information structure is determined, and finally socially optimal tariffs are set.

The offer made by RZD at the first stage of the game aims to engage the regulating authority in a trusting partnership and seek 'fair' pricing at the expense of information rent. In particular, closer cooperation, participation in board of director meetings, more transparent contractual arrangements and mutual obligations between the partners all contribute to the elimination of information asymmetry. At the second stage, local authorities may accept or reject the offer to establish trusting partnerships with a proposed corporate structure after considering whether the offer is ex ante welfare improving. With this sequencing of the game, trusting partnerships emerge endogenously as an alternative delivery model. However, as our model shows, a trusting partnership does not necessarily improve social welfare ex post.

Regarding concessionary passengers, we assume that regulator is ex ante uncertain about demand and consider an isolated effect of this assumption by making the firm's cost known to regulator. To illustrate this point, concessionary passengers are deemed as compensated directly from the budget ex post. The corresponding budget constraint may or may not be binding. In the latter case, the firm is unaware of the sufficiency of public funds, which becomes a hidden characteristic of the regulator. Thus, we have two-sided asymmetry of information features here, in which either regulator or the firm may wish to preserve status quo and refrain from bargaining.

It should be noted that the firm is always better off when the actual number of concessionary passengers is unknown to the regulator ex ante. An illustration would be the so-called monetisation reform in the suburban railway passenger sector in Russia in 2005. Non-monetary benefits in the form of various concessions were substituted by explicit compensatory schemes. In particular, Federal Government committed to cover RZD's losses associated with transportation of privileged passengers that is mandated at the national level. With additional funds coming from the federal level, regional budget constraints relaxed. One would expect that the future plans about monetisation reform could have affected the pace of the organisational transformation in the sector. Indeed, after a jump-start in 2003 when three SPCs were established the development of trusting partnerships slowed down on the eve of reform, and no partnerships were established in 2004. So, this is what Proposition 2 implies: softer budget constraint made the organisational choice of trusting partnership less likely.

Monetisation reform implemented in 2005 in Russia revealed actual demand of privileged passengers of almost all the categories for public transport. In terms of our model that would mean elimination of information asymmetry about the demand of concessionary passengers. With more certain demand, as Proposition 1 implies, the chances for trusting partnerships increased. So in 2005-2006 we observed an increase in the number of SPCs from 4 to 10.

Additional reason for the emergence of trusting partnerships in Russia was the process of fiscal centralisation during the first decade of the century. Local cash-strapped governments were unable to go beyond the budget limits and fully compensate concessionary transportation. According to Proposition 2, the incentives to be engaged in trusting relationships with the service provider would increase. Having become more constrained as a result of financial crisis in 2008 local governments agreed to establish another 7 SPCs in 2009-2010.

With regard to fare dodgers, we return to the initial assumptions with no information asymmetry and introduce a specific group of consumers that illegally avoids paying for the service and therefore not eligible for any compensation from the budget. Clearly, it is socially optimal to enforce correct behaviour among such passengers and block fare-dodgers from using transportation services. From the social point of view, the cost burden of implementation of new technologies of access control (primarily via tourniquets) is smaller when financed by the firm than the regulator due to the social cost of public funds. However, the legislative status of passenger transportation as a public service prevents the service provider in Russia from blocking the access without partnering with local authorities and acquiring the status of public service provider. In effect, a commercial firm has no legal right to collect fines for the ticketless travel, which is an administrative offence. So, the partnership with the service provider may be a viable option for the local authorities even in case of complete information.

The welfare comparison of alternative delivery models produces ambiguous results. Service provider will be better off by establishing trusting partnerships with desired (and proposed) ownership structure in all three cases, while consumers will suffer in most cases (with one exception when the service provider turns out be extremely cost-efficient). Correspondingly, tariffs will increase in most cases and decrease if the firm is very cost-efficient. In extension with fare-dodgers, when there is no information asymmetry, social welfare will definitely increase after a switch from PSO to a trusting partnership.

The proposed theoretical model and its extensions shed some light on the process of forming a trusting partnership. It rationalizes two important reasons for the delay in implementating reforms of Russia's suburban passenger transportation at the regional level. We claim that in the regions where the status quo is retained, the offer to establish trusting partnerships was either not made by RZD or rejected by the local authorities. The model also explains how different ownership structures in the existing SPCs may be formed. The descriptive power of the model goes beyond the case of suburban railway in Russia. Taking into account the diversity of different organizational choices in this sector, the model has broader applications and implications. In particular, the proposed analytical framework allows us to account for the diversity of organizational choices in the public sector that seem to be socially optimal ex ante and prove to be ambiguous in terms of welfare ex post.

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Appendix

Derivation of optimal tariff under complete information:

$$W = V(P) - [1+\lambda]T_{RS} + \alpha[Q(P)\times[P-\theta]+T_{RS}] \xrightarrow{P\geq 0} \max$$
$$s.t.\, T_{RS} \leq T$$

$$\frac{(a-bP)^2}{2b} - (1+\lambda)T + \alpha((a-bP)(P-\theta)+T) \xrightarrow{P\geq 0} \max$$

FOC: $-(a-bP)+\alpha(-b(P-\theta)+(a-bP)) = (-a+\alpha b\theta+\alpha a)+(b-2\alpha b)P = 0$

$$P = \frac{a-\alpha b\theta-\alpha a}{b(1-2\alpha)}$$

SOC: $b-2\alpha b = b(1-2\alpha)$

For the tariff found to represent solution to the optimization problem in question, the second order derivative must be negative, that is, the condition $1-2\alpha<0$ must hold, that implies $\alpha > 1/2$.

Proof of Lemma 1.

$$\frac{\partial P}{\partial \alpha} = \frac{-(b\theta+a)(b-2\alpha b)-(a-\alpha b\theta-\alpha a)(-2b)}{(b-2\alpha b)^2} = \frac{-b^2\theta+2\alpha b^2\theta-ab+2\alpha ab+2ab-2\alpha b^2\theta-2\alpha ab}{b^2(1-2\alpha)^2} =$$
$$\frac{-b^2\theta+ab}{b^2(1-2\alpha)^2} = \frac{a-b\theta}{b(1-2\alpha)^2} > 0$$

if $a-b\theta>0$ (there exists a break-even point for the firm that charges price at a marginal cost).

Proof of Lemma 2.

Here we consider the condition under which charging the tariff imposed by the regulator results in negative operating profits:

$$P = \frac{a-\alpha(b\theta+a)}{b-2\alpha b} \vee \theta$$

$$\frac{a-\alpha(b\theta+a)}{b-2\alpha b} - \theta = \frac{(a-\alpha b\theta-\alpha a)-(b\theta-2\alpha b\theta)}{b-2\alpha b} = \frac{a+\alpha b\theta-\alpha a-b\theta}{b-2\alpha b} = \frac{(1-\alpha)a-b\theta(1-\alpha)}{b-2\alpha b} =$$
$$\frac{(1-\alpha)(a-b\theta)}{b(1-2\alpha)} < 0$$

Using the previously justified condition $a-b\theta>0$ as well as derived restriction $\alpha>1/2$, we could determine that $1-\alpha>0$, that is, $\alpha<1$ is additional restriction that is needed to be placed on the parameter.

Inequality $\alpha > 1/2$ represents the required condition for internal solution to be obtained; otherwise the socially optimal tariff would be equal to 0. Yet, zero tariff is definitely less than unit product cost. As $\alpha < 1$ is the restriction naturally incorporated in our model, a general conclusion could be made that within the framework we have constructed, socially optimal tariff (one that maximizes social welfare) turns out to be lower than economically optimal tariff (tariff set at the level of marginal cost).

Proof of negative profit condition:

It is yet to be determined what restrictions on regulator's budget and consequently transfer to the monopoly keep the service provider from having its losses fully covered:

$$\pi = (a-bP)(P-\theta)+T = \left(a-b\frac{a-\alpha b\theta-\alpha a}{b-2\alpha b}\right)\left(\frac{a-\alpha b\theta-\alpha a}{b-2\alpha b}-\theta\right)+T =$$

$$\left(\frac{a(1-2\alpha)-(a-\alpha b\theta-\alpha a)}{1-2\alpha}\right)\left(\frac{(a-\alpha b\theta-\alpha a)-\theta(b-2\alpha b)}{b-2\alpha b}\right)+T =$$

$$\left(\frac{a-2\alpha a-a+\alpha b\theta+\alpha a}{1-2\alpha}\right)\left(\frac{a-\alpha b\theta-\alpha a-\theta b+2\alpha b\theta}{b-2\alpha b}\right)+T = \frac{(\alpha b\theta-\alpha a)(a+\alpha b\theta-\alpha a-\theta b)}{b(1-2\alpha)^2}+T =$$

$$\frac{\alpha(b\theta-a)(a(1-\alpha)-b\theta(1-\alpha))}{b(1-2\alpha)^2}+T = \frac{-\alpha(a-b\theta)^2(1-\alpha)}{b(1-2\alpha)^2}+T < 0$$

$$T < \frac{\alpha(a-b\theta)^2(1-\alpha)}{b(1-2\alpha)^2} \qquad \text{(A.1)}$$

Note that upper bound is positive under the restrictions imposed before, meaning there is non-empty set of values of regional budgets that makes transfer to regulated monopoly insufficient to cover its operational losses.

Proof of the Equation (1):

$$W^{PSO} = V(P)-[1+\lambda]T+\alpha\pi = \frac{\left(a-b\dfrac{a-\alpha(b\theta+a)}{b-2\alpha b}\right)^2}{2b}-(1+\lambda)T+\alpha\left(\frac{-\alpha(a-b\theta)^2(1-\alpha)}{b(1-2\alpha)^2}+T\right)=$$

$$\frac{((a-2\alpha a)-(a-\alpha b\theta-\alpha a))^2}{2b(1-2\alpha)^2}-(1+\lambda)T+\alpha\left(\frac{-\alpha(a-b\theta)^2(1-\alpha)}{b(1-2\alpha)^2}+T\right)=$$

$$\frac{(\alpha b\theta-\alpha a)^2}{2b(1-2\alpha)^2}-(1+\lambda)T+\alpha\left(\frac{-\alpha(a-b\theta)^2(1-\alpha)}{b(1-2\alpha)^2}+T\right)=$$

$$\frac{\alpha^2(a-b\theta)^2}{2b(1-2\alpha)^2}-(1+\lambda)T-\alpha\frac{\alpha(a-b\theta)^2(1-\alpha)}{b(1-2\alpha)^2}+\alpha T =$$

$$\frac{\alpha^2(a-b\theta)^2-2\alpha^2(a-b\theta)^2(1-\alpha)}{2b(1-2\alpha)^2}-(1+\lambda-\alpha)T = \frac{\alpha^2(1-2(1-\alpha))(a-b\theta)^2}{2b(1-2\alpha)^2}-(1+\lambda-\alpha)T =$$

$$\frac{-\alpha^2(1-2\alpha)(a-b\theta)^2}{2b(1-2\alpha)^2}-(1+\lambda-\alpha)T = \frac{-\alpha^2(a-b\theta)^2}{2b(1-2\alpha)}-(1+\lambda-\alpha)T$$

Derivation of the upper bound on α that guarantees operating profit to be negative:

$$P = \frac{a - \alpha bE\theta - \alpha a}{b - 2\alpha b} \vee \theta$$

$$\frac{a - \alpha bE\theta - \alpha a}{b - 2\alpha b} - \theta = \frac{(a - \alpha bE\theta - \alpha a) - \theta(b - 2\alpha b)}{b - 2\alpha b} = \frac{a(1-\alpha) - b\theta(1-\alpha) + \alpha b(\theta - E\theta)}{b - 2\alpha b} \vee 0$$

$$\frac{(a - b\theta)(1-\alpha) + \alpha b(\theta - E\theta)}{b(1-2\alpha)} < 0$$

$$(a - b\theta)(1-\alpha) + \alpha b(\theta - E\theta) > 0 \qquad \text{(A.2)}$$

$$(a - b\theta) - (a - b\theta + b(E\theta - \theta))\alpha > 0$$

$$\alpha < \frac{a - b\theta}{a - b\theta + b(E\theta - \theta)} = 1 - \frac{b(E\theta - \theta)}{a - b\theta + b(E\theta - \theta)}$$

Derivation of the upper bound on θ under which it is optimal for the service provider to opt for tariff reduction:

$$\frac{a - \alpha bE\theta - \alpha a}{b - 2\alpha b} \vee \frac{a + b\theta}{2b}$$

$$(a + b\theta)(1 - 2\alpha) \vee 2(a - \alpha bE\theta - \alpha a)$$

$$a + b\theta - 2\alpha a - 2\alpha b\theta \vee 2a - 2\alpha bE\theta - 2\alpha a$$

$$2\alpha b(E\theta - \theta) \vee a - b\theta$$

Note that inefficient firm ($\theta > E\theta$) would never opt for tariff reduction. Yet, tariff reduction could be optimal for efficient firm if:

$$(b - 2\alpha b)\theta > a - 2\alpha bE\theta$$

$$\theta < \frac{a - 2\alpha bE\theta}{b(1-2\alpha)} \qquad \text{(A.3)}$$

Proof of the Equation (2):

$$\pi_0^{PSO} = (a-bP)(P-\theta)+T =$$

$$\left(a-b\frac{a-\alpha bE\theta-\alpha a}{b-2\alpha b}\right)\left(\frac{a-\alpha bE\theta-\alpha a}{b-2\alpha b}-\theta\right)+T =$$

$$\left(\frac{a(1-2\alpha)-(a-\alpha bE\theta-\alpha a)}{1-2\alpha}\right)\left(\frac{(a-\alpha bE\theta-\alpha a)-\theta(b-2\alpha b)}{b-2\alpha b}\right)+T =$$

$$\left(\frac{a-2\alpha a-a+\alpha bE\theta+\alpha a}{1-2\alpha}\right)\left(\frac{a-\alpha bE\theta-\alpha a-b\theta+2\alpha b\theta}{b-2\alpha b}\right)+T =$$

$$\left(\frac{\alpha bE\theta-\alpha a+\alpha b\theta-\alpha b\theta}{1-2\alpha}\right)\left(\frac{a(1-\alpha)-b\theta(1-\alpha)+\alpha b(\theta-E\theta)}{b-2\alpha b}\right)+T =$$

$$\left(\frac{-\alpha(a-b\theta)}{1-2\alpha}-\frac{\alpha b(\theta-E\theta)}{1-2\alpha}\right)\left(\frac{(a-b\theta)(1-\alpha)}{b-2\alpha b}+\frac{\alpha b(\theta-E\theta)}{b-2\alpha b}\right)+T =$$

$$\left(\frac{-\alpha(a-b\theta)^2(1-\alpha)}{b(1-2\alpha)^2}+T\right)-\frac{\alpha b(\theta-E\theta)}{1-2\alpha}\frac{(a-b\theta)(1-\alpha)}{b-2\alpha b}-$$

$$\frac{\alpha b(\theta-E\theta)}{1-2\alpha}\frac{\alpha b(\theta-E\theta)}{b-2\alpha b}-\frac{\alpha(a-b\theta)}{1-2\alpha}\frac{\alpha b(\theta-E\theta)}{b-2\alpha b}=$$

$$\pi^{PSO}-\frac{\alpha(1-\alpha)b(a-b\theta)(\theta-E\theta)+\alpha^2b^2(\theta-E\theta)^2+\alpha^2b(a-b\theta)(\theta-E\theta)}{b(1-2\alpha)^2}=$$

$$\pi^{PSO}-\frac{\alpha(a-b\theta)(\theta-E\theta)+\alpha^2b(\theta-E\theta)^2}{(1-2\alpha)^2}$$

Proof of the Equation (3):

$$W_0^{PSO} = V(P)-[1+\lambda]T+\alpha\pi =$$

$$\left(V^{PSO}(P)+\frac{\alpha^2(\theta-E\theta)(a-b\theta)}{(1-2\alpha)^2}+\frac{1}{2}\frac{\alpha^2b(\theta-E\theta)^2}{(1-2\alpha)^2}\right)-(1+\lambda)T+$$

$$\alpha\left(\pi^{PSO}-\frac{\alpha(a-b\theta)(\theta-E\theta)+\alpha^2b(\theta-E\theta)^2}{(1-2\alpha)^2}\right)=$$

$$W^{PSO}+\frac{\alpha^2(\theta-E\theta)(a-b\theta)}{(1-2\alpha)^2}+\frac{1}{2}\frac{\alpha^2b(\theta-E\theta)^2}{(1-2\alpha)^2}-\alpha\frac{\alpha(a-b\theta)(\theta-E\theta)+\alpha^2b(\theta-E\theta)^2}{(1-2\alpha)^2}=$$

$$W^{PSO}+\frac{1}{2}\frac{(1-2\alpha)\alpha^2b(\theta-E\theta)^2}{(1-2\alpha)^2}=$$

$$W^{PSO}+\frac{1}{2}\frac{\alpha^2b(\theta-E\theta)^2}{1-2\alpha}<W^{PSO}$$

Supplementary derivation for the proof of Equation (3):

$$V_0^{PSO}(P)=\frac{\left(a-b\dfrac{a-\alpha bE\theta-\alpha a}{b-2\alpha b}\right)^2}{2b}=$$

$$\frac{1}{2}\frac{\left((a-2\alpha a)-(a-\alpha bE\theta-\alpha a)\right)^2}{b(1-2\alpha)^2}=$$

$$\frac{1}{2}\frac{(\alpha bE\theta-\alpha a)^2}{b(1-2\alpha)^2}=$$

$$\frac{1}{2}\frac{\alpha^2(a-b\theta+b\theta-bE\theta)^2}{b(1-2\alpha)^2}=$$

$$\frac{1}{2}\frac{\alpha^2\left((a-b\theta)^2+2(b\theta-bE\theta)(a-b\theta)+(b\theta-bE\theta)^2\right)}{b(1-2\alpha)^2}=$$

$$\frac{1}{2}\left(\frac{\alpha^2(a-b\theta)^2}{b(1-2\alpha)^2}+\frac{2\alpha^2 b(\theta-E\theta)(a-b\theta)}{b(1-2\alpha)^2}+\frac{\alpha^2 b^2(\theta-E\theta)^2}{b(1-2\alpha)^2}\right)$$

$$=V^{PSO}(P)+\frac{\alpha^2(\theta-E\theta)(a-b\theta)}{(1-2\alpha)^2}+\frac{1}{2}\frac{\alpha^2 b(\theta-E\theta)^2}{(1-2\alpha)^2}$$

Proof of deviation of trusting partnership's objective function from society's objective function decreasing with ω:

$$U_{PPP}=\omega W(P)+[1-\omega]\pi=\omega[V(P)-[1+\lambda]T+\alpha\pi]+[1-\omega]\pi=\omega V(P)-\omega[1+\lambda]T+[1-\omega[1-\alpha]]\pi=$$
$$\omega\left[V(P)-[1+\lambda]T+\frac{[1-\omega[1-\alpha]]}{\omega}\pi\right]$$

$$U_{PPP}=\omega[V(P)-[1+\lambda]T+\psi\pi]$$

where ψ is a new variable representing a relative weight placed on producer surplus in a partnership's objective function – analogue to α in regulator's objective function.

$$\psi=\frac{(1-\omega(1-\alpha))}{\omega}=\frac{1}{\omega}-(1-\alpha)=\alpha+\left(\frac{1}{\omega}-1\right)$$

$$\psi=\alpha \text{ } iff \text{ } \omega=1$$
$$\frac{\partial\psi}{\partial\omega}=-\frac{1}{\omega^2}<0 \tag{A.4}$$

Proof of the service provider being the better off the greater is its share in trusting partnership:

$$
\begin{aligned}
&\frac{\partial \pi}{\partial \omega}=\frac{\partial \pi}{\partial \psi}\frac{\partial \psi}{\partial \omega}= \\
&\quad\left(\frac{-(a-b\theta)^2(1-\psi)+\psi(a-b\theta)^2}{b(1-2\psi)^2}+2\frac{\psi(a-b\theta)^2(1-\psi)}{b(1-2\psi)^3}(-2)\right)\left(-\frac{1}{\omega^2}\right)= \\
&\quad\left(\frac{-(a-b\theta)^2(1-2\psi)}{b(1-2\psi)^2}-4\frac{\psi(a-b\theta)^2(1-\psi)}{b(1-2\psi)^3}\right)\left(-\frac{1}{\omega^2}\right)= \\
&\quad\frac{-(a-b\theta)^2\left((1-2\psi)^2+4\psi(1-\psi)\right)}{b(1-2\psi)^3}\left(-\frac{1}{\omega^2}\right)= \\
&\quad\frac{(a-b\theta)^2\left((1-4\psi+4\psi^2)+(4\psi-4\psi^2)\right)}{b(1-2\psi)^3}\frac{1}{\omega^2}= \\
&\quad\frac{(a-b\theta)^2}{b(1-2\psi)^3}\frac{1}{\omega^2}<0
\end{aligned}
\tag{A.5}
$$

Derivation of social welfare function under trusting partnership:

$$
\begin{aligned}
EU_{PPP}&=E\left(\omega\left(\frac{-\psi^2(a-b\theta)^2}{2b(1-2\psi)}-(1+\lambda-\psi)T\right)\right)=\omega\left(\frac{-\psi^2E(a-b\theta)^2}{2b(1-2\psi)}-(1+\lambda-\psi)T\right)= \\
&\quad\omega\left(\frac{-\psi^2\left[b^2\sigma_\theta^2+(a-bE\theta)^2\right]}{2b(1-2\psi)}-(1+\lambda-\psi)T\right)
\end{aligned}
$$

Derivation of optimal tariff under Extension 1:

$$
\begin{aligned}
W&=CS(P)+U_{CP}-[1+\lambda]T+\alpha[\pi(P)+T]= \\
&\quad\frac{(a-bP)^2}{2b}+U_{CP}-(1+\lambda)\theta E\tilde{a}+\alpha\left(P(a-bP)-\theta(a-bP+\tilde{a})+\theta E\tilde{a}\right) \\
&\quad\frac{(a-bP)^2}{2b}+U_{CP}-(1+\lambda)\theta E\tilde{a}+\alpha\left((P-\theta)(a-bP)+\theta(E\tilde{a}-\tilde{a})\right)
\end{aligned}
$$

$$
FOC:\frac{\partial W}{\partial P}=-(a-bP)+\alpha(a-2bP+b\theta)=\left(-a+\alpha(a+b\theta)\right)+(b-2\alpha b)P=0
$$

Proof the expected effect of information asymmetry elimination on social welfare is zero under unlimited budget for compensation of concessionary passengers' transportation

Under such an assumption, once the actual number of concessionary passengers is revealed, the service provider will obtain the transfer $\theta\tilde{a}$. Expected transfer based on actual number of concessionary passengers is thus $ET=E(\theta\tilde{a})=\theta E\tilde{a}$ as the unit product cost of providing the service is assumed to be known and exogenously determined. However, this equals to transfer based on expected number of concessionary passengers, that is, one paid under compensatory agreement. Consequently, the expected effect of information asymmetry elimination on social welfare is zero. The reason is that the transfer represents the linear function of the number of concessionary passengers in this case (see Fig 1 a,b).

Analytical proof of the expectation of compensation for transporting concessionary passengers to be reduced:

$$f(E\tilde{a}) \vee Ef(\tilde{a})$$

$$Ef(\tilde{a}) = \sum_{i=1}^{N} p_i f(\tilde{a}_i) = \sum_{i=1}^{n} p_i \theta \tilde{a}_i + \sum_{i=n+1}^{N} p_i A$$

where $\theta\tilde{a}_n < A < \theta\tilde{a}_{n+1}$.

Yet, the transfer paid under compensatory agreement could either be lower than the transfer based on expected number of concessionary passengers or not, and both these possibilities are further investigated.

If under compensatory agreement the service provider is fully compensated for expected number of concessionary passengers,

$$f(E\tilde{a}) = f\left(\sum_{i=1}^{N} p_i \tilde{a}_i\right) = \theta \sum_{i=1}^{N} p_i \tilde{a}_i = \sum_{i=1}^{N} p_i \theta\tilde{a}_i = \sum_{i=1}^{n} p_i \theta\tilde{a}_i + \sum_{i=n+1}^{N} p_i \theta\tilde{a}_i$$

so that

$$f(E\tilde{a}) \vee Ef(\tilde{a})$$

$$\sum_{i=1}^{n} p_i \theta\tilde{a}_i + \sum_{i=n+1}^{N} p_i \theta\tilde{a}_i \vee \sum_{i=1}^{n} p_i \theta\tilde{a}_i + \sum_{i=n+1}^{N} p_i A$$

$$\sum_{i=n+1}^{N} p_i \theta\tilde{a}_i \vee \sum_{i=n+1}^{N} p_i A$$

$$\sum_{i=n+1}^{N} p_i (\theta\tilde{a}_i - A) \vee 0$$

$$\sum_{i=n+1}^{N} p_i (\theta\tilde{a}_i - A) > 0$$

If under compensatory agreement, the service provider is not fully compensated for expected number of concessionary passengers,

$$f(E\tilde{a}) = f\left(\sum_{i=1}^{N} p_i \tilde{a}_i\right) = A = A\sum_{i=1}^{N} p_i = \sum_{i=1}^{N} p_i A = \sum_{i=1}^{n} p_i A + \sum_{i=n+1}^{N} p_i A$$

so that

$$f\left(E\tilde{a}\right)\vee Ef\left(\tilde{a}\right)$$

$$\sum_{i=1}^{n} p_i A + \sum_{i=n+1}^{N} p_i A \vee \sum_{i=1}^{n} p_i \theta \tilde{a}_i + \sum_{i=n+1}^{N} p_i A$$

$$\sum_{i=1}^{n} p_i A \vee \sum_{i=1}^{n} p_i \theta \tilde{a}_i$$

$$\sum_{i=1}^{n} p_i \left(A - \theta \tilde{a}_i\right) \vee 0$$

$$\sum_{i=1}^{n} p_i \left(A - \theta \tilde{a}_i\right) > 0$$

Proof that the service provider will be better off under Extension with concessionary passengers

In case of the offer being accepted the service provider is better off. Indeed, the service provider obtains higher tariff anyway. If actual number of concessionary passengers is lower than expected, he could either be compensated less yet fully, what he has accounted for when deciding on optimal share in a partnership, or the same in case of budget available being even lower. If the actual number of concessionary passengers is higher than expected, he would have to be compensated more, but even if not compensated fully, he would be compensated not less than before.

Derivation of optimal tariff under Extension with fare dodgers (no access blocking):

$$W = \frac{\left((a_1 + a_2) - (b_1 - b_2)P\right)^2}{2(b_1 - b_2)} + \alpha\left(P(a_1 - b_1 P) - \theta\left((a_1 + a_2) - (b_1 - b_2)P\right)\right)$$

$$FOC : \frac{\partial W}{\partial P} = -\left((a_1 + a_2) - (b_1 - b_2)P\right) + \alpha\left(a_1 - 2b_1 P + \theta(b_1 - b_2)\right) =$$
$$\left(-(a_1 + a_2) + \alpha\left(a_1 + \theta(b_1 - b_2)\right)\right) + \left((b_1 - b_2) - 2\alpha b_1\right)P = 0$$

$$SOC : (b_1 - b_2) - 2\alpha b_1 < 0$$

$$P = \frac{-(a_1 + a_2) + \alpha\left(a_1 + \theta(b_1 - b_2)\right)}{-(b_1 - b_2) + 2\alpha b_1}$$

Derivation of optimal tariff under Extension with fare dodgers (complete access blocking):

$$W = \frac{\left((a_1 + a_2) - (b_1 - b_2)P\right)^2}{2(b_1 - b_2)} - (1 + \lambda)F + \alpha\left((P - \theta)\left((a_1 + a_2) - (b_1 - b_2)P\right)\right)$$

$$FOC : \frac{\partial W}{\partial P} = -\left((a_1 + a_2) - (b_1 - b_2)P\right) + \alpha\left((a_1 + a_2) - 2(b_1 - b_2)P + \theta(b_1 - b_2)\right) =$$
$$\left(-(a_1 + a_2) + \alpha\left((a_1 + a_2) + \theta(b_1 - b_2)\right)\right) + \left((b_1 - b_2) - 2\alpha(b_1 - b_2)\right)P = 0$$

$$SOC : (b_1 - b_2) - 2\alpha(b_1 - b_2) < 0$$

$$P = \frac{-(a_1 + a_2) + \alpha((a_1 + a_2) + \theta(b_1 - b_2))}{-(b_1 - b_2) + 2\alpha(b_1 - b_2)}$$

Proof of the increase in tariff becoming optimal as a result of access to the service by free-riders being blocked

As nominator is increased by αa_1 while denominator is reduced by $2\alpha b_2$, both nominator and denominator remain positive, and tariff is increased as a result of blocking free riders from the service. This result is an intuitive one. The tariff representing a solution to social welfare maximization was set at such a level, that marginal loss to consumer surplus from tariff increase was equal to marginal gain to producer surplus from tariff increase multiplied by α. With free riders turned into fee paying passengers, marginal gain to producer surplus from higher tariff weighted by α exceeds the corresponding marginal cost to consumer surplus, which is unaffected by the change. Consequently, higher tariff becomes socially optimal.