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Rothbauer, Julia; Sieg, Gernot

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„Quality standards for passenger trains: Political majorities and environmental costs“

by Julia Rothbauer and
Gernot Sieg,
March 2010

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Address
Institut für Volkswirtschaftslehre
Spielmannstraße 9
D38106 Braunschweig, Germany

Telephone
+49 531 391 2578

Website
http://www.tu-braunschweig.de/vwl

Fax
+49 531 391 2593

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Quality standards for passenger trains: Political majorities and environmental costs

Julia Rothbauer*
Gernot Sieg*

March 18, 2010

Abstract

This study analyzes the minimum quality standard set by the European Union (EU) through Regulation 1371/2007 of Rail Passengers' Rights and Obligations. A welfare maximizing quality standard raises quality and consumer satisfaction, but does not improve the modal split of rail transport. A minimum quality standard determined by political majorities may or may not increase welfare. However, all binding standards induce travelers to switch to transport modes with higher anthropogenic greenhouse gas emissions.

Keywords: regulation; minimum quality standards; median; rail

JEL: L51; L92; D72

1 Introduction

On the 3 December, 2007 a regulation on rail passengers' rights and obligations was published in the Official Journal of the European Union. The regulation contained rules regarding delays, missed trains, and train cancellations, to improve the quality. For example, the minimal compensation for a delay of 60 to 119 minutes was set at 25% of the ticket price. All quality regulations had to be implemented by Member States till the 3 December 2009. The objective mentioned in the preamble was "to help increase the share of rail transport in relation to other modes of transport" (European Union, 2007, p. 14). The transportation sector is

*TU Braunschweig, Economics Department, Spielmannstr. 9, 38106 Braunschweig, Germany

one of the main sources of anthropogenic greenhouse gas emissions and an increased modal split of the railway sector may reduce CO_2 emissions. A sample-rail-trip from Berlin to Paris produces 33 kg carbon dioxide per passenger compared to 115.4 kg per passenger for the same trip by car, or 203.5 kg by air.[1] However, a consumer survey for the European Commission reveals that consumers are not satisfied with rail transport. Rail is the only transport mode by which less than 50% of the respondents are satisfied. Furthermore, about 25% of the respondents have experienced problems with this service in the last 12 months. In contrast, only about 15% of the respondents have had problems with new motor vehicles or air transport (Eurostat, 2009). Therefore, it seems obvious that a quality regulation is an appropriate policy to increase the modal share of rail transport.

It is well known that a monopolist may undersupply quality. In most EU-member countries the market for rail passenger transport is still highly concentrated. Companies, aside from the incumbent, that is, the former monopolist, have hardly more than 10% of the market share (European Commission, 2009). For a given quantity of supply, the monopolist undersupplies quality if the average valuation of quality is higher than the valuation of the marginal consumer, because the welfare optimum is given by averages, but prices signal marginal valuations (Spence, 1975; Sheshinski, 1976). Therefore, the market power of incumbents is likely to be the cause of low satisfaction and a quality regulation might solve this problem.

There are many dimensions of quality in rail transport (Nathanail, 2008): system safety, cleanliness, passenger comfort, servicing, such as, frequency of service and speed, passenger information, and itinerary accuracy. Furthermore, consumers have different preferences in this multidimensional quality space (Lyons et al., 2007; Teichert et al., 2008; Bhadra, 2009). Punctuality is more important for short distance than for long distance travel. The willingness to pay for speed increases with the opportunity costs of time and therefore business travelers have a higher willingness than travelers visiting friends and relatives or holiday travelers. Commuters value high frequency and punctuality much more than travelers visiting friends and relatives or holiday travelers. To summarize, the regulation of one dimension of quality, itinerary accuracy, affects different types of consumers differently.

The effects of minimum quality standards when consumers are heterogeneous are complex (Sappington, 2005). Besanko et al. (1987) show that a monopolist that sells in a market in which consumers differ in their willingness to pay for quality will distort and enhance the range of products offered for sale. A minimum quality standard will result in the exclusion of consumers from the market, relative to the unregulated equilibrium, whereas, in general the effect on social welfare

[1] Values according to www.ecopassenger.org where emissions for individual travel routes are computable.

is ambiguous. Kluger (1989) shows that a minimum quality standard alters the entire price and quality schedule offered by a monopolist. However, there are many reasons why transport firms do not offer a full range of punctuality qualities, except one. This article shows that exclusion of consumers occurs even if the monopolist has to offer only one type of quality. Furthermore, the effects of the standard on social welfare are determined in our article. Leland (1979) considers a market with asymmetric information concerning quality. In public transport by train there may be no information about the expected arrival time, but there is no systematic asymmetric information about punctuality. Most of the data is available through the net and consumers do know what quality a rail firm offers. Besanko et al. (1988) consider a monopolist who is not able to observe the consumers' preferences for product quality and show that a rate of return regulation may counteract the quality distortion. However, in the European Union (EU) we do not have a regulation for rail transport firms, but we have a process of transforming state-owned firms to profit-oriented firms. We therefore consider profit maximizing firms facing minimum quality standards. Sibly (2009) raises a question similar to our problem. However, his result states that if there are two types of customers for public transport, the quality of the public transport system is downwardly skewed, which is the starting point of our analysis.

This article shows that even though there is an undersupply of quality in the market for rail transport and quality regulation raises quality and consumer satisfaction, the resulting policy does not improve the modal split. Furthermore, if the minimum level of quality is not the result of a benevolent welfare maximizing dictator, but the result of pressure group politics, the regulation is only coincidentally welfare optimal. The outcome depends on the power of railway companies on the one side and consumer pressure groups on the other side. We show that in case railway companies have little influence on the decision-making process and democratic ballots in the group of rail users solely determine the quality regulation, then welfare decreases. The reason for these non-intended perverse effects is that even though all consumers prefer a higher quality the willingness to pay for quality differs between consumers. Whereas the monopolist uses the market power and the higher quality to increase the price, some consumers do not think the rise in quality justifies the higher price, and therefore, quit using the train. Furthermore, non-rail users do not even vote if the ballot is about regulating rail transport. Voter abstinence aggravates quality distortion. A quality regulation will not increase the mode share of rail transport.

2 The model

Following Besanko et al. (1987), we assume that railway transport can be produced in a continuous array of quality levels, or punctuality, denoted by q, where $q \in [0, \infty)$. There are constant unit costs $C(q)$ with $C(0) = 0$, $C'(q) > 0$, and $C'' > 0$. For simplicity:

$$C(q) = \beta \cdot q^2,$$

with $\beta > 0$, similar to Lambertini (2006, p.11). The monopolist can offer only one price / quality combination.[2]

Every consumer travels at most once per period of time and the number of consumers is normalized to one. The consumer's utility is approximated by: $U = y + V(q, \theta)$ with $V'(q) > 0$ and $V'' < 0$, where y is a composite commodity and V is the total willingness to pay for quality (see Mussa and Rosen, 1978).

We use θ as the parameter capturing the consumers' heterogenous preferences for quality. There are travelers visiting friends and relatives and holiday travelers, which have a small θ, because they have weak preferences for punctuality. However, there are also commuters, who value punctuality much more than travelers visiting friends and relatives or holiday travelers. These commuters have a high θ. Business travelers have a medium preference for punctuality, because speed is more important. Therefore, they are represented by a medium θ. In our model θ is equally distributed over an interval $[\theta_0, \theta_1]$. To model the diversity of consumers we assume $\theta_1/\theta_0 > (0.1(7 - 3\sqrt{5}))^{-1} =: \alpha_W^{-1}$, which is trivially fulfilled for $\theta_0 = 0$ and guarantees a demand smaller than one.

For every type of consumer willingness to pay for quality V increases as quality increases, but with a diminishing rate. Furthermore, we assume that the total and marginal willingness to pay for quality increases in the taste parameter. A simple form to model these preferences is

$$V(q, \theta) = \sqrt{\theta \cdot q}$$

A consumer of taste type θ buys if $\sqrt{\theta q} \geq p$. The consumer $\tilde{\theta} = p^2/q$ is indifferent to buying. Consequently, all consumers $\tilde{\theta} \leq \theta \leq \theta_1$ buy, and therefore, demand equals

$$D(p, q) = \frac{\theta_1 - \tilde{\theta}}{\theta_1 - \theta_0} = \frac{\theta_1 - p^2/q}{\theta_1 - \theta_0},$$

if $p^2/q < \theta_1$ and zero otherwise. The demand function fulfills the law of demand. With regard to quality, the demand increases as quality increases. Therefore, ignoring any other reactions a quality increase through a regulation increases the

[2] β is the costs per passenger unit at quality normalized to one and we assume constant returns to scale, i.e. constant unit costs on the technical side independent of quality.

share of rail transport, as indicated in the EU regulation. Note also that this demand function is nonlinear with respect to price. If demand was linear a monopolist would distort the price only because nonlinearity is a necessary condition for quality distortion (Spence, 1975).

2.1 Welfare optimum

As a benchmark the combination of price and quality (Point W in Figure 1) that maximizes the sum of consumer surplus and profits equals

$$q_W = \alpha_W^{1/3} \cdot \frac{\theta_1^{1/3}}{\beta^{2/3}},\ p_W = \alpha_W^{2/3} \cdot \frac{\theta_1^{2/3}}{\beta^{1/3}},\ \text{and } x_W = (1-\alpha_W) \cdot \frac{\theta_1}{\theta_1 - \theta_0}.$$

2.2 Unregulated Monopoly

As the appendix shows, the unregulated monopolist (Point M in Figure 1) maximizes profits by

$$q_M = \frac{\theta_1^{1/3}}{2 \cdot 5^{1/3} \cdot \beta^{2/3}},\ p_M = \frac{\theta_1^{2/3}}{5^{2/3} \cdot \beta^{1/3}},\ \text{and } x_M = 0.6 \cdot \frac{\theta_1}{\theta_1 - \theta_0}.$$

The quality provided by the monopolist is c.p. too low because

$$\frac{\partial W}{\partial q}|_{p=p_M, q=q_M} = \frac{25\sqrt{2} \cdot 5^{1/6}\beta^{1/3}\theta_1^{4/3} - 4 \cdot 5^{2/3}\beta^{1/3}\theta_1^{4/3}}{75(\theta_1 - \theta_0)} > 0.$$

The monopolist undersupplies quality because the quantity restriction is severe (Spence, 1975). A simple comparison of the monopolist's quality and the welfare maximizing quality could induce the ambition to increase quality in order to improve welfare.

3 Regulation of quality

Although there are a variety of possible modes of regulation, this article analyzes the minimum quality standards as set by the European Union. Therefore, we consider only the case where the policy maker decides the quality and the monopolist then decides on the optimal price. Therefore, the policy maker acts as a Stackelberg-leader.

The monopolists reaction function is given by

$$p(q) = \frac{1}{3} \cdot (\beta q^2 + \sqrt{\beta^2 q^4 + 3q\theta_1})$$

with

$$\frac{dp}{dq} = \frac{1}{3}(2\beta q + \frac{4\beta^2 q^3 + 3\theta_1}{2 \cdot \sqrt{\beta^2 q^4 + 3q\theta_1}}) > 0.$$

Anticipating the increase in price on quality standards, the regulator maximizes welfare by setting the quality to

$$q_R \approx 0.298514 \cdot \frac{\theta_1^{1/3}}{\beta^{2/3}} > q_M.$$

As the regulator only sets the quality, but not the price, the monopolist is able to increase the price to

$$p_R \approx 0.346542 \cdot \frac{\theta_1^{2/3}}{\beta^{1/3}} > p_M.$$

The price increase in turn leads to an exclusion of market participants:

$$x_R \approx 0.597702 \cdot \frac{\theta_1}{\theta_1 - \theta_0} < x_M.$$

To summarize, a welfare maximizing regulation enhances quality and improves welfare (Point R in Figure 1). However, the regulation decreases the modal share of the rail sector and is no measure to reduce greenhouse gas emissions if travelers use cars or planes instead.

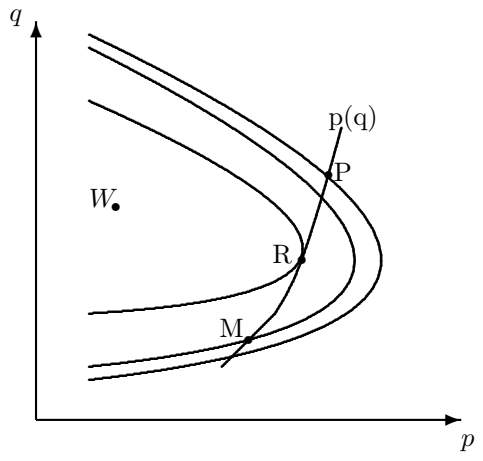

Figure 1: Prices and qualities in different regulatory regimes

4 Political Regulation

In a two party system the quality regulation policies of the parties converge to the policy preferred by the median voter, if every citizen votes, because preferences are single peaked (Black, 1948). The median voter is

$$MV = \frac{\theta_1 + \theta_0}{2}.$$

The indirect utility of the median voter is given by

$$NU_{MV} = \frac{1}{3}(-\beta q^2 - \sqrt{\beta^2 q^4 + 3q\theta_1}) + \frac{\sqrt{q(\theta_1 + \theta_0)}}{\sqrt{2}} + y$$

and

$$\frac{\partial NU_{MV}}{\partial q}|_{q=q_M} = \frac{\beta^{1/3}(-28 \cdot \sqrt{5}\sqrt{\theta_1} + 55\sqrt{\theta_1 + \theta_0})}{22 \cdot 5^{5/6}\theta_1^{1/6}},$$

is negative because $\theta_1/\theta_0 > 1/\alpha_W$. In a ballot about quality regulation, a maximum quality standard (and not a minimum quality standard) outpolls the unregulated monopoly. Quality reduction results in a lower price, and voters with a low willingness to pay for quality, which are the majority, benefit.

However, the European Union did not decrease the quality, but increased it. There are many reasons as to why the median voter's preferred outcome is not the outcome of the political process (Aranson and Ordeshook, 1981), and abstention from voting (Hinich and Ordeshook, 1969) is most important in the case of passenger transport by rail. The regulation of quality of passenger transport effects consumers differently. Some consumers obtain a higher net-surplus through the regulation. These are the consumers with high willingness to pay for quality, such as business travelers, who vote in favor of the regulation. Consumers with low willingness to pay for quality, such as holiday travelers and travelers visiting friends and relatives, oppose the regulation. By establishing the regulation, a part of these consumers are excluded from the market and are thus losing consumer surplus. Furthermore, some consumers do not leave the market, but still have a loss of surplus. Finally, there are potential consumers who do not even buy in the low quality unregulated monopoly. As they do not receive any consumer surplus they are indifferent to the unregulated monopoly and minimum quality standards. We assume, that these voters have no interest in the decision-making process and abstain from the ballot. The effect is called abstention from indifference (Hinich and Ordeshook, 1969).

We assume the status quo of the non-regulated market. The median of the current users increases his net-utility by claiming a higher quality. A political agent has to follow this claim for higher quality in order to maximize his vote

share by increasing the minimum standard of quality. As a result the monopolist increases the price and even more consumers leave the market, changing the group of remaining consumers. As a result, the median of the consumer group shifts upward. As long as the median, after a quality increase, prefers an even higher quality, a politician can improve his vote share by increasing the quality.

Consumers who do not use rail transport abstain from a ballot about quality regulation in the rail sector. Furthermore, in the ballot only the votes cast are valid, and therefore, the vote share is relevant. This assumption about voting abstinence results in a quality q_P that cannot be outvoted by a different minimum quality proposal. In the equilibrium, no quality change increases the share of voters preferring the changed quality even though the change of consumers due to the quality change is anticipated.

Two conditions determine the equilibrium (q_P, θ_P). First, for a given median θ^M the median voter theorem holds, which means the ballot winning quality maximizes the net utility NU of the median voter:

$$NU_{\theta^M}(q_P) \geq NU_{\theta^M}(q) \forall q.$$

Second, θ_P has to be the median of consumers who travel by train if the quality is q_P.

To get the median voter for a given quality q we use the net utility of consumer θ for a given q. That is,

$$NU_\theta(q) = \sqrt{\theta \cdot q} - \frac{1}{3}(\beta q^2 + \sqrt{\beta^2 q^4 + 3q\theta_1}).$$

By setting $NU_\theta(q) = 0$ we get the marginal consumer as a function of q:

$$\theta(q) = \frac{1}{9}(2\beta^2 q^3 + 3\theta_1 + 2\beta q\sqrt{\beta^2 q^4 + 3q\theta_1}).$$

Therefore, for a given quality q the median of travelers by train is

$$\theta^M(q) = \frac{\theta_1 + \theta(q)}{2},$$

and therefore the median voter for the ballot winning quality is

$$\theta_P = \frac{\theta_1 + \theta(q_P)}{2}$$

receiving a net utility of

$$NU_{\theta_P}(q) = \sqrt{\theta_P \cdot q} - \frac{1}{3}(\beta q^2 + \sqrt{\beta^2 q^4 + 3q\theta_1}).$$

Because q_P maximizes $NU_{\theta_P}(q)$ we use the first order condition to specify

$$q_P \approx 0.319319 \cdot \frac{\theta_1^{1/3}}{\beta^{2/3}},\ p_P = 0.362005 \cdot \frac{\theta_1^{2/3}}{\beta^{1/3}} > p_R,\ \text{and}\ x_P = 0.589603 \cdot \frac{\theta_1}{\theta_1 - \theta_0}.$$

Welfare decreases to

$$W_P = \frac{0.21756 \cdot \theta_1^{5/3}}{\beta^{1/3}(\theta_1 - \theta_0)} < W_M.$$

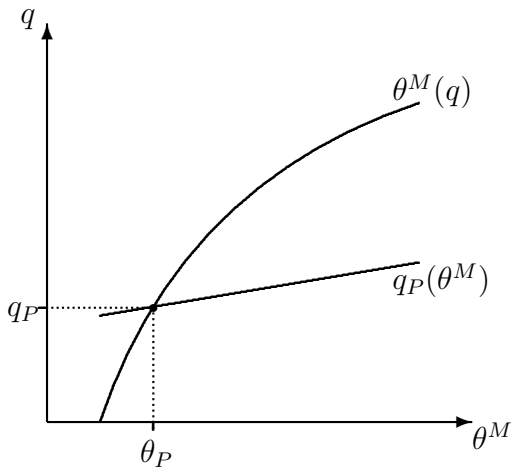

Figure 2: Political Equilibrium

The quality demanded by the median of rail travelers is larger than the welfare maximizing minimum quality standard as well as the quality offered by the unregulated monopolist. Furthermore, a regulation following the demands of rail travelers decreases welfare even when compared to the unregulated monopoly. Last but not least, this type of regulation decreases the modal share of the rail sector and is the worst policy with regard to the greenhouse gas emissions.

Stigler (1971) and Peltzman (1976) argue that regulation is not induced by a benevolent welfare maximizing decision maker or by the median of voters, but by pressure groups. Following Peltzman (1976) we consider two groups struggling to influence the regulator, producers, that is, the railway company, and rail travelers. Depending on the influence, the resulting regulatory policy is either q_M, if only the monopolist is important, or q_P, if only voters count. However, in reality both groups are important and the regulator chooses a quality from $[q_M, q_P]$, such that the marginal votes lost from consumers because of a lower quality are outweighed by the votes (arguably indirectly) won from the railway company. Note that

this implies that the competition of pressure groups may also lead to the welfare optimal regulatory minimum quality standard q_R (Becker, 1983).

To summarize, following Peltzman (1976), the decision-making process in the European Union results in a minimum quality standard that is somewhere in $[q_M, q_P]$, and may or may not increase welfare. However, if there is no price or rate of return regulation, a binding minimum standard of quality causes the monopolist to raise prices, inducing consumers to quit traveling by rail. The substitution of the ecological preferred transport mode by modes with higher emissions counteracts the aim of the regulator to fight anthropogenic greenhouse gas emissions.

5 Conclusion

Within the scope of implementation of the EU Regulation of Passenger Rights the member states have great latitude. On the one hand, the member states may postpone parts of the regulation, especially the minimum quality standard for itinerary accuracy, for up to 15 years. On the other hand, minimum standards are not binding and member states are free to increase quality beyond the regulation. In fact, passenger rights vary throughout the EU. According to our model this variation of standards is a result of varying proportions of power among the group of rail passengers and the rail monopolist.

Empirical research about the relation of pressure groups and the regulation in the EU member states is necessary to test our hypothesis. As a benchmark we refer to Switzerland, which is not part of the EU and therefore not affected by the regulation. For a direct democracy our model predicts a small quality standard. Switzerland's compensation payments are in line with the EU minimum requirements.

Although the welfare effect of the EU regulation is ambiguous, the regulatory minimum quality standard decreases the share of rail transport in the model split. Regulation of the monopolist's pricing policy can prevent this unintentional effect if the regulated price does not increase, even if the quality increases. It is well known that rate of return and price cap regulations can deter the railway company from disproportionate price increases. Spence (1975) shows that a rate of return regulation improves the quality provided by a monopolist if capital is a factor of production. However, if some part of the quality is labor-using, the rate of return regulation diminishes it. In a price-regulated market entry of new companies induce incumbent companies to move quality in the welfare-maximizing direction (Beil et al., 1995). Thus, encouraging entry into the rail passenger transport market might be an option. Gal-Or (1983) demonstrates that in a market without price regulation, entry might decrease average quality, but it increases the aggregate output. To summarize, in order to increase the share of passenger rail

transport in the modal split, a policy that creates competition is appropriate. As a positive side effect the influence of pressure groups is reduced. Furthermore, firms have an incentive to produce different qualities in an oligopolistic market (Motta, 1993; Shaked and Sutton, 1982), following which a minimum quality standard might be a policy to increase welfare as well as to improve the model split (Ronnen, 1991). Moreover, differentiated qualities better fit the needs of heterogeneous customers.

To summarize, the pressure group's influence on the minimum quality standards in the European Union, unintentionally decrease the rail transport share. To increase the quality options for travelers and to reduce anthropogenic greenhouse gas emissions a noteworthy alternative is a policy to support entry into the rail passenger transport market. Increased competition reduces the influence of pressure groups and might induce the production of differentiated qualities. As entry also increases the output, more passengers will use trains instead of other transport modes with higher emissions. Encouraging new firms to enter the market for passenger transport by rail and supporting competition is, compared to a regulation of quality, a superior policy to fight global warming.

Appendix

Welfare optimum

All Consumers with $\theta \geq \theta_W = p^2/q$ buy one unit. Gross consumer surplus equals

$$CR = \frac{1}{\theta_1 - \theta_0} \int_{\theta_W}^{\theta_1} \sqrt{\theta q} d\theta = \frac{2}{3} \cdot \frac{(q \cdot \theta_1)^{3/2} - p^3}{q(\theta_1 - \theta_0)}.$$

Total costs are

$$TC = \beta q^2 \frac{\theta_1 - \theta_W}{\theta_1 - \theta_0}$$

and total surplus equals $W = CR - TC$, which is maximized by q_W, p_W, and x_W reaching a value of

$$W_W = \frac{(7 - 5\alpha_W)^{1/3}(50\sqrt{\alpha_W} - (1 + 40\alpha_W))}{3 \cdot 5^{5/3}(\theta_1 - \theta_0)} \frac{\theta_1^{5/3}}{\beta^{1/3}}$$

The firms profit Π_W is zero. The marginal consumer is $\theta_W = \alpha_W \theta_1$.

Monopoly

A monopolist maximizes profits

$$\Pi = [p - C(q)]D(q)$$

by using the first order conditions

$$\frac{\partial \Pi}{\partial p} = 0 \Longrightarrow p = \frac{1}{3} \cdot (\beta q^2 \pm \sqrt{\beta^2 q^4 + 3q\theta_1})$$

and

$$\frac{\partial \Pi}{\partial q} = -C' D(p,q) + (p - C(q)) \frac{\partial D(p,q)}{\partial q} = 0.$$

Firm's profit is $\Pi_M = \frac{9\theta_1^{5/3}}{20 \cdot 5^{2/3} \beta^{1/3} (\theta_1 - \theta_0)}$ and welfare yields $W_M = -\frac{(\frac{5\theta_1^{2/3}}{\beta^{1/3}} - \frac{4\sqrt{10} \cdot \theta_1^{2/3}}{\beta^{1/3}})\theta_1}{12 \cdot 5^{2/3} (\theta_1 - \theta_0)}$.

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