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Railway's Regulatory Reform: assessing its impact on the safety of services

Abstract

This paper aims to shed light on the impacts of the early 90's rail regulatory reform on the safety of its services. By running an unbalanced panel with 11 OECD countries, covering the period 1980 to 2001, we find that regulatory regimes where the passenger operator was made the residual claimant of its profits are more successful in improving the safety of its services. The idea behind this result is that lower levels of safety are connected to higher costs. Another side result is that vertical unbundling of the industry was not able to provide statistically significant changes in safety.

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1 Introduction

The strengh of the new theory of regulation, developed during the end 70's and 80's, can be measured by the industrial reform agenda of the last 15 years which took over most developed (and not a few underdeveloped) countries. Nonetheless, challenges are numerous when the theoretical framework should be translated into its actual implementation. Clearly, the practicionners and theoreticians' lack of understanding of crucial industries' specificities and information structure can compromise the expected results.

The rail industry in a number of OECD countries has experienced major structural changes in the last ten years, such as privatization and vertical separation. Additionally, though the reforms followed a similar trend, they differed accross countries, specially on the regulatory regime choices[1] .

The objective of this paper is to shed some light into the preliminary results obtained by the deregulation of railways in one of its most sensitive outputs: quality of services. Specifically, we investigate the effect of the power of regulatory regimes and vertical unbundling on one of its dimensions: the safety of services.

The relevance of this variable is remarkable for the rail industry. Together with the traditional production targets imposed to the industry, the 90's reform aimed at restoring the falling level of service, which did not correspond to the correspondent increasing subsidies. Though safety has not been in the spotlight of the debate regarding quality of services, its evolution is closely related to its reliability and infrastructure investments.

[1] Gonenc et al. (2000) provides a broad study on what happened in major rail industries around the world.

The starting point of our analysis is that the major problem for regulators in the rail industry is not the lack of information on the efficiency of the firm, but its inability to contract the rail firm services. Taking the quality of the rail track as not contractible, we assume that the relevant informational problem is the one of moral hazard.

Although either high-powered or low-powered regulation may be optimal under different fundamentals, some countries use high-powered incentive schemes such as price cap regulation and others low-powered incentive schemes such as cost plus regulation[2] .

In this article, we use the inverse of the number of accidents as a proxy for safety of rail services. We conjecture that high-powered regulation is optimal. Under this type of regulation, any accident's related cost directly affects the firm's budget as its revenue is based on the price settled by the regulator. Therefore, the rail company is interested in reducing the level of accidents as much as possible. In contrast, low-powered regimes, where the government virtually assures the rail firm's revenue, provides a poorer record to decrease the number of accidents.

Lastly, the separation of the rail industry into operating companies and infrastructure managers is analysed as regard as its effect on safety. We obtain a statistically null impact. Preliminary investigations indicate that important coordination failures could be behind this result, as completely new markets have been created and market players are still learning their way through.

Our analysis proceeds as follows: the next section presents the review of the empirical

[2] We do not investigate the reasons behind the regulatory regime choice by one country or another, though they are relevant to understanding our results.

literature concerning the impact of incentive regulation on the quality of railway services and surveys the related findings in the telecommunications industry; the third section proposes a simple model for the operator's behaviour; the fourth section provides the description of the data and a characterization of the industry; the fifth section, the estimation's results and finally, the last section concludes with our main findings.

2 Review of the literature

Our paper contributes to two branches of the empirical economic literature: (1) the impact of incentive regulation on the quality of services and (2) the understanding of the railways technology and consequently the operator's incentives.

The empirical literature on the impacts of regulation on the quality of railways services is very insipient. During the period this article was written, no other study has been found on the impact of incentive regulation on the quality or safety of services. Pollit et all (2002) have provided only a superficial study of the impacts of reform in UK on the reliability of the urban rail system.

The lack of studies does not correspond to its huge public demand. One explanation for this mismatch is that such data on quality of services is very poor. In fact, most of the operators only started to gather and publicize their information on punctuality and frequency. Nevertheless, operators performance cannot be compared because each uses a different measure for punctuality, for instance. Because the only data on quality available was the number of accidents, we have to concentrate in this particular dimension of their services.

Clearly, we should not expect that the impact of incentive regulation on safety be the same for other dimensions since the technology has a crucial role on the way incentives play their part. Our guess is that reliability and environmental dimensions do not affect the costs of companies as much as safety, which is able to disrupt traffic and damage or destroy assets. If a train is late five minutes, its marginal impact on the company's budget can be throught demand response in the future or, more directly, in the coordination costs with other train operators or within the operator's train. All these features are just a small proportion of the total costs from accidents.

Some empirical studies in the telecommunications industry found that the impact of incentive regulation on quality was not straightforward[3] . While there is a common understanding that stronger regimes lead to a deterioration of the quality of services[4] , no evidence was found that this strategy was followed among the Bell Operating Companies in the US (Taylor and Tardiff, 1993). The same was true for the AT&T performance under price cap regulation. The UK case studies were not as straightforward as in the US. Most interestingly, Oftel (now known as OfCom) was able to indentify that different quality dimensions were affected differently by the incentive regulation. Kridel at all (1996) remark in their survey on the empirical findings in the telecommunications industry that such effect should be better qualified as the operators might have improved their quality records in order to

[3] This industry is very generous with data on quality of its services.

[4] Sappington (2004) provides a survey on the theoretical findings over the regulation of service quality.

prevent a radical change in the next regulatory period.

The studies on the impact of this recent reform are still very few and mostly (if not only) concentrates on its impact on production output. Friebel et all (2003) study the effect of different reform styles on the efficiency level of European operators. They have found that the reforms that were implemented sequentially improved the companies efficiency better than simultaneous reforms, that had a null impact. Moreover, they have not found any evidence that full separation of infrastructure from operations imply enhanced railroad efficiency[5] .

3 The model

In this section, we develop a model that explains the operator's choice over safety given the incentives provided by the regulator. We distinguish between two technologies regarding safety: one regards remeding its immediate impacts, which is presented in the next subsection, and the other regards preventing its fall, presented in the section 3.2.

3.1 The technology of the passanger operator

The passenger operator offers the service of providing the transport of passengers between two cities serviced by a rail infrastructure (tracks, stations facilities etc). We assume this service is characterized by two activities (or dimensions): the activities related to production and the ones related to safety. These activities are assumed to be technically complementary

[5] There are numerous efficiency studies on railways, but that do not deal with this recent reform. The interested reader is refered to Oum et al. (1994) and Nash et al (2004).

to eachother[6] . In this context, the operator is a multiproduct firm that allocates its resources between these two activities. It chooses to concentrate resources on production whenever safety is high, however, when safety is low, the operator has to concentrate its resources on the safety related activities, compromising the production level. The safety related activities include the coverage of the costs incured from accidents such as injuries and damage to property and eventually the damages from the lost of human life. In this case, a train accident, for example, would imply transfer of resources from production to the repairment of assets and the payment of possible damages to passengers.

We characterize this technologycal substitutability between production and *low* safety through an adjusted Cobb-Douglas. Let Q and s be respectively the quantity and safety produced and z_i, $i = 1, ..., n$ be the inputs, the short-term production function is:

$$Q = As \prod_{i=1}^{n} z_i^{\alpha_i} K^{\alpha_K},$$

where $\alpha_i \geq 0 \;\; \forall i$, where A, α_i and α_K represent the parameters describing the technology. Note that, similarly to the usual single-output production function, the technology is such that one combination of inputs, $z_1, ..., z_n$, produces a 'safety adjusted quantity', $\hat{Q} = \frac{Q}{s}$.

The optimization program of the operator is such that he first chooses the amount of

[6] Here, complementarity is restricted to the industry's technology. Note that this notion is different from the one that relates quality increase to consumer's net marginal willigness to pay, measured by the difference between price and marginal cost. For more references on this latter notion see Tirole (1988, p. 100-2).

inputs $(z_1, ..., z_n)$ that minimizes its (variable) costs given their prices w_i, Q and s:

$$\begin{aligned} Min_{\{z_i\}_i^n} \ C &= \sum_{i=1}^{n} w_i z_i \\ subject\ to\ \frac{Q}{s} &= A \prod_{i=1}^{n} z_i^{\alpha_i} K^{\alpha_K} \end{aligned}$$

Then, its cost-minimizing (value) function will be:

$$C(Q, s, w) = \left(\frac{1}{A} \frac{Q}{s} \right)^{\frac{1}{r}} \theta \prod_{i=1}^{n} w_i^{\frac{\alpha_i}{r}} K^{-\frac{\alpha_K}{r}} \quad (1)$$

where $r = \sum_{i=1}^{n} \alpha_i$, and θ is a function of the technological parameters $\alpha_1, ..., \alpha_n$.

It is easy to see that the passenger operator faces a cost function that is increasing with quantity and decreasing with safety, an expected result if we assume that low safety implies reallocation of resources to activities related to *remeding* its impacts.

3.2 The incentives and the *preventive* cost function

Assume further that the passanger operator is a monopolist that can be subject to regulation by a national authority, which we call the regulator. The regulator sets the prices and the supply Q. However, we assume the regulator is not able to set binding regulation on safety. The idea behind this assumption is that the safety performance as well as the other quality dimensions of the industry are seldom enforced by regulators. The (few but) recent studies on the implementation of penalty systems in railways find an industry with a history of rare punishments over low performance[7] .

[7] The interested reader is refered to NERA (2000), BOB (2003) and ET-DG (2003).

If there is regulation, it can be of two forms: cost plus or fixed price. Under the cost plus regime, the regulator receives the latter's commercial revenue, R, and pays the operating costs, C, plus a transfer t_0. Under the fixed price regime, the operator is the residual claimant of the operator's costs. Under no regulation, the operator does not receive any transfer from the government

The operator's final payoff U is given according to this institutional setting. More formally:

$$U = \begin{cases} R(Q) - C(Q,s,w,K) - \psi(Q,s,w,K) & \text{if No regulation} \\ t_0 + R(Q) - C(Q,s,w,K) - \psi(Q,s,w,K) & \text{if Fixed price} \\ t_0 - \psi(Q,s,w,K) & \text{if Cost plus} \end{cases}, \tag{2}$$

where $\psi(Q,s,w,K)$ is our *preventive* cost function. It entails the short run costs of ensuring preventive measures against accidents such as double checks, accuracy and security of the network's coordination and training programs. Then, it is crucially different from the costs associated with the repairment of damages from accidents, as presented in section 3.1.

We assume this *preventive* technology is labor intensive, as it entangles an important change in the staff routine. However, its impact on safety is proportional to the impact of the quantity produced. Under this technology, the measure of interest is the units of labor per quantity produced, that is, $\frac{L}{Q}$, that affects positively the level of safety.

Furthermore, the level of capital is assumed to be an important part of the operator's preventive costs. Given the elevated maintenance costs that arise from a high level of capital, we conjecturate that capital participation has a negative impact on the preventive costs. Notably, by introducing K and Q in the *production of safety*, we account for the scale and size of the operator in his costs of preventing accidents.

Then, $\psi(Q,s,w,K)$ actually represents the value function of another optimization problem of the operator, who minimizes labor costs subject to a safety level s, which is a function of L, Q and K. Formally:

$$\begin{aligned}\psi(Q,s,w,K) &= Min_L \; w_L L \\ st \; s &= s\left(\frac{L}{Q},K\right),\end{aligned}$$

where $s\left(\frac{L}{Q},K\right) = \left(\frac{L}{Q}\right)^{\gamma_L} K^{-\gamma_K}$. Note that, in the preventive technology, safety and quantity are substitutes. Then, the value function of the preventive cost is:

$$\psi(Q,s,w,K) = (w_L Q)\, s^{\gamma} K^{\delta} \tag{3}$$

where $\gamma = \frac{1}{\gamma_L}, \delta = \frac{\gamma_K}{\gamma_L}$. Consequently, the preventive costs are an increasing function of wages, quantity and capital.

Lets turn back to the incentives of the operator. Its payoff expression 2 can be rewritten as follows:

$$U = \zeta t_0 + (R(Q) - C(Q,s,w,K))\,(1-\zeta+\zeta\rho) - \psi(Q,s,w,K)$$

where $\zeta = \{0,1\}$ when the operator is $\{not\ regulated, regulated\}$ and $\rho = \{0,1\}$ when the operator faces a $\{cost\ plus, fixed\ price\}$ regulatory regime.

In this stage, the monopolist will choose s that maximizes its payoff U:

$$\psi'(Q,s,w,K) = -\,(1-\zeta+\zeta\rho)\, C_s(Q,s,w,K)$$

Notably, s is higher whenever there is no regulation or the regime chosen is fixed price. When the regime is cost plus, the operator provides a lower level of safety.

From 1 and 3, the explicit solution for s is:

$$s = \Delta \Phi^{\frac{r}{\gamma r+1}} Q^{\frac{1-r}{\gamma r+1}} w_L^{\frac{\alpha_L - r}{\gamma r+1}} \prod_{i \neq L}^{n} w_i^{\frac{\alpha_i}{\gamma r+1}} K^{-\frac{\alpha_K + r\delta}{r}} \tag{4}$$

where $\Delta = \left(\frac{\theta}{r\gamma}\frac{1}{A^{1/r}}\right)^{\frac{r}{\gamma r+1}}$ and $\Phi = (1 - \zeta + \zeta\rho)$ is the dummy for the regulatory regime.

The homogeneity property of degree one in input prices allows the parameters of this decision rule to be identified[8] . Once again, under the most powerful regime or no regulation, the operator is incentivized to increase safety. For all inputs different from labor and capital, the impact of a raise in its prices leads to an increase in the level of safety. This is so because the operator would be willing to compensate the increase in costs by improving safety, which enables not to reduce production.

According to our model, the net impact of quantity, labor prices and capital can be either positive or negative on the optimal level of safety. As discussed, production and safety are complementary activities when the operator chooses the combination of inputs. However, when he has to *invest* on the preventive measures regarding safety, these activities become substitutes. In our model, whenever there are increasing returns to scale, the impact of

[8] Explicitly, we have the following system of n+3 equations and n+3 variables:

$$\begin{array}{lll} a = \frac{r}{\gamma r+1} & c_i = \frac{\alpha_i}{\gamma r+1} \forall i \neq L & e = -\frac{\alpha_K + r\delta}{r} \\ b = \frac{1-r}{\gamma r+1} & d = \frac{\alpha_L - r}{\gamma r+1} & \sum \alpha_i + \alpha_K = r \end{array}$$

and we solve it w.r.t. $\alpha_L, \alpha_K, \alpha_i \forall i \neq L, r, \gamma, \delta$. The solution is:

$$\begin{array}{lll} \alpha_L = \frac{a+d}{a+b} & \alpha_i = \frac{c_i}{a+b} \forall i \neq L & \gamma = \frac{1-b-a}{a} \\ \alpha_K = -\frac{c+d}{a+b} & r = \frac{a}{a+b} & \delta = \frac{c+d-e}{a} \end{array}.$$

production on safety becomes negative. In fact, while the preventive costs increase in the same proportion as the output increases, the same is not true under increasing returns to scale. In this case, an increase in the output leads to a lower increase costs related to remeding impacts of safety.

An increase in the level of capital has a negative impact on the level of safety. There are two reasons for that: (1) since we are looking at variable costs, increase in the level of capital leads to a downward shift of the latter; and (2) the level of capital has a negative impact on the preventive costs of the operator. Both features give scope to the operator to reduce the level of safety.

Also, safety is a decreasing function of the technical efficiency parameter A. It means that a more efficient operator is capable to transform the same combination of inputs into more output, which reduces its need to have a high level of safety. Under this technology, we would expect that the more efficient is the operator, taking other incentives constant, the lower are its level of safety.

The linearized version of the expression 4 is as follows:

$$\ln s = \bar{\Delta} + a\Phi + b \ln Q + \sum_{j \neq L}^{n} c_j \ln w_j + d \ln w_L + e \ln K \tag{5}$$

where $(a, b, c_1, ..., c_n, d, e)$ are the parameters of the regression and $\bar{\Delta} = \ln \Delta$.

It is usefull here to make a distinction between the capacity or quantity supplied, which is chosen by the regulator,and the level of transports demanded by the customers. The recent empirical literature on network industries have questioned the fact that, though both variables are strongly correlated, the latter is not as much under the control of the regulator once the network size and the capacity have been settled. Basically, customers make their decisions on the number travels they will make in a year once the regulated price and the supply are decided[9] .

In this sense, it might be also true that the regulator's decision on Q is a function of the national demand features such as population density and the actual level of transports demanded. Formally, we assume the following linear relationship:

$$Q = \varphi(q, X),$$

where q is quantity of transports that were sold and X are demand characteristics.

4 The industry and the data

We have runned an unbalanced panel with yearly information on 11 OECD rail passanger companies, namely VR(Finland), SNCF(France), DBahn (Germany), JR Central (Japan), FS Spar (Italy), NV (Netherlands), RENFE (Spain), DSB(Denmark), SNCB (Belgium), SJ (Sweden) and OEBB (Austria), covering the period of 1980 to 2000. For each country, the information on the regulatory regime, number of accidents, production, profit and input prices, specifically, labour and energy prices were made available.

The data sources where widespread. The labour prices, classified according to the STAN-2000 industrial classification, where from the OECD OLIS database. It means that the most disaggregated industry data obtained was transport and storage sector . The

[9] The related literature makes then a distinction between the intermediate output, that is offered by the rail operator, and the final output, that is produced by the customers. The idea is that the customers use the train-or seat-kilometers offered by the rail companies as inputs in their production of passenger-kilometers, their ultimate variable of interest. For more on the discussion, the reader is refered to Berechman (1993).

energy prices are industry prices for kW/h and were obtained through the International Energy Association[10] . The input prices are in American dollars, corrected by its PPI.

The information on the regulatory regime choice is based on the OECD International Database on Regulation. In this database, gathered during 1998, the countries were asked to answer questions about their respective regulatory regimes in industries such as telecommunications, energy, railways and air transport. One of the questions was on which regulatory regime the national passanger railways company was subject to. Table 1 lists the regulatory regimes for some of the interviewed countries.

The announced regulatory regimes seem to be consistent with the policy each of these countries have been adopting in the last five years, but a remark should be made about the countries that have declared themselves with 'No regulation', Germany, Finland and Spain. A closer look into their institutional setting implies that such declaration should be carefully interpreted. As an ilustration, once you look at the ownership structure of the main railway company of these countries, they are all public. Additionally, at least one of them, the Spanish Renfe was imposed limit on the losses it could incurr. Therefore, it is not straightforward whether 'No Regulation' means no inteference by the respective national government[11] .

The Table 1 also figures the regulatory regime per vertical structure of the railway industry. In fact, one can measure the a government's compromise towards reforming the

[10] Appendix A provides the descriptive statistics of these input prices.

[11] For a more precise description of these countries' policies, the reader is refered to Seabright et all (2003), Cantos and Campos (2003), CER (2000a, b, c), ECMT (1998), Yarrow and Vickers (1993), OECD (2000), Helm (2002).

industry by looking at the level of unbundling of the industry. Notably, the many of the countries that have not unbundled operation from infrastructure management have acknowledged the importance of such exercise - they have imposed separation of accounts (Table 2) - but have not gone throught with the reform. Therefore, we conjecture that these countries have limited themselves to a superficial reform. The impact of such reform on the relevance of the regulatory reform is to be understood.

Table 2 provides the year of the 'comprehensive reform' used in this study as the approximation of the moment the regulatory regimes were adopted. For most of them, it corresponds to the year the Directive 91/440 was adopted by the respective national law. The Directive 91/440 represented a sharp change in the European rail policy. Besides creating the basis for the improvement of the commercial and financial independency of railways and realistic balance sheets, it aimed at making rail infrastructure available in equal and fair terms to other operations. Furthermore, it required transparency in the contracts that demanded public service obligations (Friebel et all, 2003). Despite its objectives, little progress was observed and competition among operators is not generally observed [12] .

Against this approximation, one can argue that the changes were already foreseen since 1991, when the directive was issued at the European level. However, its effect on the actual day-to-day practices in the industry is more concrete once the law actually reaches the national level[13] . Additionally, the Table 2 provides the year of vertical separation or

[12] See Appendix 2 for the current status of the competition in the industry.

[13] In fact, this measure can be proven very sensitive to the quantity variables. As an example, Friebel et all (2003) perform an efficiency study that has taken into account not only the year of the reform but the way it was implemented.

the separation of accounts of the railway industry in each country, when it was the case. Notably, this industry's regulatory reform was mostly concentrated during the period 1994 to 1998

The level of accidents were made available by the Union des Chemin de Fer, an international representative of the industry. It is the sum of four types of accidents: derailments, collisions, accidents at level crossings and others[14] . In order to give a measure of the asset utilization, the typical unit of account for the transport industry was adopted, traffic-unit-kilometres (TUK), which is the sum of ton-kilometres and passenger-kilometres. This information was obtained through the Worldbank public database on railways, an excelent industry dataset. The level of safety is then measured as the inverse of accidents per ten thousands TUKs.

A main shortcomings of this measure is the differed way accidents are measured across some of the sampled countries. Nevertheless, as it is the dependent variable in our regression, it should not affect the estimation of the parameters of interest, only the constant[15] .

[14] For a detailed description of each type of accident, see the appendix.

[15] Let $N(a)$ be the reported level of accidents and $N(a^*)$, the true number of accidents. Then, if some accidents are not accounted because its damage was not so high, we have the following function for an accident to be considered one in country i:

$$a_i = \begin{cases} 1 \text{ if } damage \geq d_i \\ 0 \quad \text{otherwise} \end{cases}$$

Similarly, we have the same rule for another country j. If $d_i > d_j$, then the number of accidents in country j would be relatively overrepresented. Formally:

$$N(a_j^*) = N(a_j) + N(\tilde{a}_j), \text{where } \tilde{a}_j = \begin{cases} 1 \text{ if } d_j < damage < d_i \\ 0 \quad \text{otherwise} \end{cases}$$

Its effect on the classical normal regression model is a upward bias on the constant estimates, since we are looking at safety rather than accidents.

Additionally, one can argue the existence of reversed causality between safety and the choice of regulatory regime. In fact, once the regulator knows the operator's technology, they might have chosen a regime according to the previously observed safety level. Though most of the countries in our sample has its own rail safety body, the driving force towards reform has been introducing competitive practices in the industry, via incentive regulation or via introduction of new players in the industry. In this context, the role of rail's reliability, that is, punctuality and frequency, become crucial. Therefore, if safety and reliability share some meaningul correlation, one could argue with more confidence on this reversed causality.

On the other hand, such feature would not compromise the qualitative interpretation of the results, as it would imply a downward bias in the dummies' estimates. As a consequence, our estimates would be, in the worst case, conservative, which is a preferable bias to have.

Table 3 show the accident averages per country before and after the regulatory regime change. Notably, the countries that have adopted the cost plus regimes are the ones that present the lower average percentual change, with 30% decrease in the level of accidents. The countries that have adopted no regulation or fixed price performed better: 49% and 52% decrease in the level of accidents. The table also shows that the level of accidents differs accross regimes and this is specially true for the countries that have chosen the fixed price regime, that have a higher average.

Invoking the discussion on a previous paragraph, the data is not strongly supporting the assumption that accidents are explained solely by the regulatory regimes. A more formal test should be carried out to answer definitively whether the endogeneity problem is relevant.

Nevertheless, the fact that there might exist this reversed causality among the choice of the regulatory regime's power and safety only strengthen our results, since it implies a downward bias in our estimators.

5 The application of the model

In the following, we present the application of the model to our dataset, then the estimation methodology and its results.

5.1 The decision rule

In the section 3, we assumed that safety was chosen strategically, given input prices and the regulatory regime. In this section, we further specify the regression of interest 5 by assuming that energy is an input, besides labor and capital. The regression of interest is:

$$\begin{aligned} \ln s_{it} &= \bar{\Delta}_{it} + b \ln Q_{it} + c \ln w_{Nit} + d \ln w_{Lit} \\ &\quad + e \ln K_{it} + f NI_{it} \left(1 + \sum_{h=1}^{3} a_h D_{hit} \right) + n\Gamma + \varepsilon_{it} \end{aligned} \tag{6}$$

where i accounts for country, t for year and $(a_1, a_2, a_3, b, c, d, e, f, n)$ are the linear combinations of our structural parameters. The impact of regulation, though, is measured simply through $a_h f$.

The variables $(D_{1it}, D_{2it}, D_{3it})$ are respectively the dummies for fixed price, cost plus and no-regulation regimes. They are step dummies, that is, they assume the value 1 starting from the year the country adopted a comprehensive reform in its rail industry, and zero otherwise. The complement of the dummies correspond to the period when no change has occurred[16] . In our sample, no country experimented the whole sample period without regulatory change.

Differently from our model, that treated both fixed-price and no-regulation as having the same impact on the incentives of the railways operator, we here allow for the distinction among the regimes. This way, we are able to test empirically whether both regimes can be treated as such.

We also control for the *deepness* of the reform in the related countries. We assume that the regulatory regimes are only implemented in the countries that have gone through the vertical separation of operation of services from infra-structure management. Then, the countries that have made regulatory reforms but have not separated its activities are assumed not to have actually implemented the regimes they have announced. They are: Belgium, Spain, Italy and Austria[17] .

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[16] Formally speaking, let $\hat{t}$ be the year of reform. The dummies are the following:

$$
\begin{aligned}
D_{0it} &= \begin{cases} 1 & \text{if all } t \geq \hat{t} \\ 0 & \text{otherwise} \end{cases} ; \\
D_{1it} &= \begin{cases} 1 & \text{if all } t \geq \hat{t} \text{ and adopted fixed price} \\ 0 & \text{otherwise} \end{cases} ; \\
D_{2it} &= \begin{cases} 1 & \text{if all } t \geq \hat{t} \text{ and adopted cost plus} \\ 0 & \text{otherwise} \end{cases} ; \\
D_{3it} &= \begin{cases} 1 & \text{if all } t \geq \hat{t} \text{ and adopted no regulation} \\ 0 & \text{otherwise} \end{cases} .
\end{aligned}
$$

Again, our complementary dummy corresponds to the period when no reform took place, that is, when $D_{0it} = 0$.

[17] In fact, Austria and Belgium have not announced the 'basis of regulation' of their passenger services at the OECD survey. For these countries (and France too), we relied on information from other studies on the state-of-the-arts railways regulation to arrive to a conclusion towards the type of regime that is implemented. Therefore, the assumption on the impact of regulation given the vertical structure of the railway industry is quite appropriate, as it rely more heavily on the industry structure than subjective analysis.

Respectively, w_{Lit} and w_{Nit} are the wage and energy prices of operator i in year t. Note that, as input prices and safety are in natural logaritms, their parameter estimates, $\hat{\delta}_1$ and $\hat{\delta}_2$, can be interpreted as input price elasticities: the percentage change in the safety of services for a 1% change in input prices.

We further add a trend Γ in order to control for technological change and a step dummy NI, informing if the rail industry has been unbundled, that is, separated into operator and infrastructure management. It assumes the value 1 starting from the year the operator had its passenger operations separated from infrastructure, and zero otherwise.

The constant $\bar{\Delta}_{it}$ is the respective operator's fixed effect, which accounts for its technological level, and ε_{it} is the disturbance term.

The quantity supplied is measured as train-km. To control for the fact that the regulator might be deciding the Q as a function of the demand, we have instrumented this variable with the following ones: the level of passangers-km, that approximates the demand for railway transport, the population and country area, to get a measure of the population density and gni per capita to account for the increase in the customer's wealth from one year to another.

5.2 The estimation method

We choose to estimate the parameters of this decision rule through a two-stage least squares panel data with fixed effects. The fixed effects model does not rule out the possible correlation between the fixed effect and the other explanatory variables - the case for the random effects model. Such feature is useful in our model because it might be the case that the choice over the regulatory regime be correlated to certain country specificities, which in turn are not captured in the model. By allowing for correlation between the individual term and other explanatory variables, we are able to make marginal inferences, conditional on these characteristics.

At this point, it is important to discuss the truncated feature of our measure of safety, the inverse of the number accidents. The variable we have adopted, number of accidents, is different from what we would be willing to have as measure of safety, which is the propensity of the railway operator to perform a service with a higher level of safety. Since we have what is commonly called in the literature a censored dependent variable, the computed conditional expectations would be biased downwards, since it is censored from below.

A way to fix for this feature is to run a non-linear model, more specifically, a tobit model that conditions the dependent variable to the fact that we only observe part of its actual distribution, that corresponds to the inverse of the non negative number of accidents. However, by performing a linear OLS panel data regression on the dataset, the predicted safety levels presents no strange behaviour, that is, the predicted accident level are still positive, which may indicate that this feature does not lead to a strong downward bias in our estimates. Nevertheless, if there is a bias, it is not the bad bias because it implies that the impact of regulation is not being overestimated, but underestimated. In other words, the downward bias implies that our estimates are quite conservative ones.

5.3 The estimation results

The estimation results are presented in Table 4 according to the model specification, which vary slightly according to the including dummy interaction of vertical separation with the regulatory regimes, and including or not capital, measured as route-km. The Model 2 corresponds to our regression equation 6.

We have a significant impact of labor and capital in the decision of safety level. However, electricity prices have null impact, for all model specifications. The trend has a positive and highly significant impact on safety, which indicates that technological progress has been playing an important role in the evolution of safety.

The structural parameters estimates are such that, for our technology specification, the industry presents constant returns to scale. The empirical literature on railways have found consistently that this industry presents increasing returns to scale. Frequently, these studies assume that a railway operator produces single or multiple output, but they seldom (or never) include the safety of services as a co-product (not to mention quality of services). When considered as a multi-output industry, both passenger and freight services are accounted[18] . While in these models, the different outputs enter in the production function as substitutes, in our model production and safety are complementaries. Then, the same combination of inputs can produce as much output as possible provided that safety is increased as well. However, the provision of output is *limited* by the regulator, that sets the supply according to demand features. The fact that we have consistently found constant returns to scale provides evidence that the introduction of safety in the production function softens the expected economies of scale of this industry. In fact, by letting accidents generate this reallocation of resources from production to the remeding the accidents's impacts, the use

[18] For references on multi-output studies on railways, see Coelli and Perelman (1996), Friebel et al (2003).

of inputs become more restricted.

The impact of labour on the production function was around 0,50 (Table 5). This estimate varied significantly from Model 1 to 2, which corroborates our choice towards the latter's specification. Specifically, under Model 1, where no interacion with the regulatory regime dummy is not allowed, the participation of labor on the production function is very small, ranging around 0,01. The reason behind this result is that railways' labour in countries the that have not gone through a meaningful reform is still unproductive. Our estimates only reflect this sharp difference between the countries that have gone through an important reform from the ones that haven't. This is also reflected in the preventive technology's parameters. It seems that it differs accross countries that have gone through reform from the ones that have not. A similar discussion applies to the level of capital.

The net impact of wages on the safety of services, the parameter d in regression 6, is consistently negative and significant at 1% level, which indicates that the preventive technology is labour intensive. In fact, the estimated structural parameter γ_L,that is the participation of labour per unit supplied on the prevention of accidents reaches $2,42$ for the Model 2. This high value justifies the fact that an increase in wages leads to big drop on safety.

The vertical separation dummy, our proxy for the degree of the industrial reform, has a negative impact on safety. When this dummy interacts with the regulatory regime dummies, its impact alone on safety is of $-0,55$ at 1% significance level for the railway operators.

Finally, we obtain that both the effects of the 'Fixed Price' and 'No Regulation' are positive and significant for all models. Reversibly, the cost plus regulation has a null effect on safety. In the Model 2, where we controlled for deepness of the industrial reform, we obtained that the fixed price regime implied a increase by 0,71 at 1% level of statistical significance on safety while no regulation implied 0,95 for also 1% level of significance. Interestingly enough, we also obtain that 'No Regulation' and 'Fixed Price' have statistically equivalent effects on safety for all model specifications, which is in tune with our theoretical model.

Econometric considerations In our estimation procedure, we have adopted the fixed effects model rather than the random effect one. The difference between the two models is that, in the fixed model, the national operators' technology can be distinguished through a constant translation of the conditional expectation function (or the regression function), while in the random effects model, such translation is not constant. Behind the choice of the fixed effect model is the conviction that these countries where not chosen randomly from a large sample, what would justify the adoption of the random effects model. In fact, such approach finds echo in the empirical literature, that usually assume the fixed effects model.

We have performed one test for random effects: the Breusch-Pagan (1980) test based on the OLS residuals. We found that the variance of the individual random component is statistically far different from zero, providing a first indication that the fixed effect model might not best fit the data.

On the other hand, the models 1, 2 and 3 present a high correlation between the individual term and the other explanatory variables, while the models 4 and 5 present a very low level of correlation, indicating that the level of capital, route-km, might be behind the source of correlation. In fact, the level of route-km has been object of important regulation, but in a minor degree when compared with production output, our train-km measure. While some operators have kept the operating the same routes, others have been released from operating them. In many cases, the government has auctioned the right to operate unprofitable routes to other parties in exchange of some duable remuneration (sometimes the incumbent itself operates the route). Then, once we take into account that the railway reform included the re-evaluation of routes profitability and, therefore, the rationalization of its use, the identified correlation expected.

In particular, when model 2's estimates are compared with model 5, that is, when we do not control for the level of route-kms the impact of No Regulation on safety decreases considerably. The same is true when we compare model 1 with 4. Notably, a better qualification of the meaning of No Regulation becomes important here as it seems that the related countries are performing important policies towards the reallocation of route-kms.

We would be interest in testing whether the regression as a whole is significant in explaining safety. The following analysis is pertinent for the model 2, but these results carry on for the other models. The equivalent test is the F statistic of the regression, assuming all slopes are equal to zero. We obtain for the Model 2 a high enough value F statistic which goes against the validity of this hypothesis under any confidence level.

Another test is whether the individual fixed effect modelling is relevant in our framework. The F statistics that test the joint significant of the country effect is $F(9, 114) = 15,67$.

The evidence is strongly in favour of the country specific effect in the data.

5.4 Discussion

We have choosen vertical separation as a proxy for measuring the *deepness* of industrial reform that a country have gone throught. We found that not only vertical integration have proven to be a good measure (see discussion on its impact on the structural parameters' estimates), but it also have given interesting insights on the way the railway industry reform has affected the safety of services. There are two non excludent explanations for this outcome. First, taking it as a proxy to the degree of industrial reform, the arrival of new players in the market and the uncertainty towards the new regulation might have led to a temporary mismatch between the traditional players in the market. Second, taking it as vertical separation of activities between operators and infrastructure managers, it might have been responsible for the apparent lack of coordination in investments and real time operation problems.

Most importantly, we obtain that high-powered incentives elicits safer rail services than the lower-powered regimes, as foreseen in our model[19] .

As discussed, it seems that the sort of 'no regulation' that is being implemented in the respective countries is such that elicits operators to perform well on safety. Our theoretical model qualifies this regulation as providing the same incentives as the fixed price regulation, but here the operators are the actual claimants of its profits. The government would not

[19] Note that, though we call them fixed price or cost plus regimes, they should not be interpreted as being implemented *per se*, but as proxy to these polar regimes.

have any participation in the budget. However, for all the countries that are *subject to* 'no regulation', the main railway incumbent has not been vertically separated and have remained public companies.

As suggested already in Kridel et al (1996), there are several possible pitfalls in the interpretation of the empirical findings of typical incentive regulation studies. Here, we discuss the implication of two of them in our estimates for 'No Regulation': the *competition pitfall* and the *mandated vs motivated pitfall*. The *competition pitfall* entails the failure by the econometrician to account that incentive regulation was introduced together with competition. The *mandated vs motivated pitfall* is identified when the operator is oblighted by contract to follow certain policies. In this case, the change of policies is not due to enhanced incentives but to a mandated policy. Furthermore, the governments that 'impose' no regulation might for this reason have determined new or expanded service quality regulation.

The first pitfall relates to the German case, where the government has focused on the introduction of competition in the industry as better instrument to regulate the market. The second pitfall seems to be the case of Spain, where the regulatory reform implied major public investments in the modernization of operations and infrastructure.

Then, it is not straightforward that the appropriate industrial agency is not intrusive on the incumbent's activities. In addition, the level of competition observed in their respective industries differs. While in Germany there are numerous operators competing in the same track, in Spain and Finland, such competition is feeble or inexistent. Therefore, it seems that either introduction of competition or government interference are behind their good performance. However, it is beyond the scope of this paper to investigate the reason why these regulators have issued this sort of 'no regulation'.

6 Conclusions

In the light of the model presented, we obtained that a regulatory regime that uses cost as the main instrument is able to affect the operator's policy regarding safety. Taking into account that low safety records increase costs, a regulatory regime that makes the operator the residual claimant of its profits will have necessarily a positive effect on safety.

We have assumed that the regulator cannot observe the efforts made by the rail firm to improve safety. Furthermore, we claim that the adverse selection problem is not relevant[20] . Then, in a moral hazard context, a powerful regime is more successful in terms of eliciting the highest cost reducing effort. Given that the firms' revenue is based essentially on the price determined by the regulator, any accident affects directly the firm's allocations of resources, which is diverted to asset repairments, eventual fines from the regulator and private suits. As a consequence, costs increase. A profit maximizing rail operator would be interested in reducing the level of accidents as much as possible provided that its costs of preventing accidents is not prohibitive. These are precisely the results obtained in this study. Reversely, the low power regimes, where the government virtually assures the rail firm's revenue, provides a poorer record on safety.

[20] In fact, it is hard to imagine that the government, represented by the rail regulator, does not have information on the technological possibilities of the industry it recently managed and/or owned.

The same qualitative results are not expected for other quality dimensions of the rail services, such as reliability and environment. In a context where penalty systems of some quality dimensions are rather weak (NERA, 2000, ET-DG, 2003), accidents provide a differentiated impact on the budget. Nevertheless, it gives a proxy of what could be expected from regulatory regimes with broader and more effective penalty systems.

As regard the negative impact of vertical separation of railway operators from infrastructure, it seems that coordination failures and learning are playing an important role in the industry, as industry's players are failing to coordinate the transition to fully separated activities.

Lastly, the causality between the regulatory regime choice and the level of safety might be reversed. In fact, it is known that the falling reliability of rail services (punctuality and frequency), together with the increasing need for subsidies was one of the major forces towards reform[21] . Therefore, the choice of regulatory regimes might not be exogenous, but related to the previous level of safety: lower level of quality would call for stronger regulatory regimes, that is, the adoption of a regime that is closer to fixed price. A preliminary study indicates such feature plays a role. However, the estimation bias is such that our estimates become conservative with respect to the effect of incentive regulation on safety. Therefore, the qualitative interpretations of our results are not compromised, as we are interested in their relative performance.

[21] The accident performance was seldom put on the spot as a reason for the market restructuring. The UK case is an exception. Still, if safety is posively related other quality dimensions, this feature can be even more important.

This study provides some preliminary insight on the efficacy of regulatory regimes regarding an specific dimension of rail quality and the importance of addressing properly the structure of the industry and the distribution of information between its players - rail companies, regulator and customers. A powerful regime is only effective with respect to safety due to the specific technology of the industry, which automatically punishes the operator that fails to provide a high enough safety level.

A complete study on the impact of regulation on the the provision of railway services is left undo in the empirical literature. As discussed already in Kridel et al (1996), the study of the impact of regulation cannot preclude the fact the such choice is not exogenous, but a result of an endogenous process. On the top of that, regulators might well be subject to political forces and institutional settings that prevent them from doing their job properly. In such case, institutional endowments and the incentive structure to which the regulator is subject to should be taken into account if a complete study is to be performed. The agenda of empirical industrial organization studies that aim at tackling the effect of regulation or regulatory reform in a set of companies should acknowledge the forces driving choices regarding incentive regulation.

Table 1: Regulatory regimes in passanger services per vertical structure

Regulatory Regime/ Vertical structure		Fixed Price	Cost Plus	No Regulation
Vertically Integrated		Belgium*	Spain	Italy*, Austria*
Non- Vertically Integrated	Public Operator	Denmark, Sweden	Finland, Germany	France
	Private Operator	Netherlands	-	-

* The national rail company have separated accounts of operations from infrastructure.

Table 2: Year of Institutional Reform in the Railway Industry

Country	Year of Vertical Separation	Year of Separation of Accounts	Year of comprehensive reform
Japan			1987
Sweden	1988		1988
Spain			1994
Netherlands	1988		1994
Germany	1994		1994
France	1997		1994
Finland	1995		1995
Austria		1993	1997
Belgium		1997	1997
Italy		1998	1998
Denmark		1997	1998

Source: Vibes, Friebel, Ivaldi, (2003), CER (2000), Gonenc, Nicoletti (2002), ECMT (1998).

Table 3: Average of Accidents per Country and Regulatory Regime

(number of accidents per 10^6 TUK)

Regulatory Regime	Before	After	Percentual Change
No regulation			-49%
Finland	0,019	0,006	-68%
Spain	0,005	0,003	-32%
Germany*	0,009	0,005	-48%
Cost Plus			-30%
France	0,003	0,003	-18%
Italy	0,004	0,002	-55%
Japan		0,001	
Austria	0,008	0,007	-17%
Price Cap			-52%
Belgium	0,015	0,007	-57%
Netherlands	0,017		
Denmark	0,086	0,033	-62%
Sweden	0,011	0,007	-37%

Table 4: Estimation results of the fixed effect panel data model

Safety	Model 1	Model 2	Model 3	Model 4	Model 5
Train-Km	-0.244	0.661	-0.403	-0.816	-0.264
	(0.753)	(0.431)	(0.650)	(0.251)	(0.729)
Wages	-0.377***	-0.354***	-0.402***	-0.343***	-0.311**
	(0.004)	(0.006)	(0.002)	(0.009)	(0.013)
Electricity	0.108	-0.236	0.069	0.165	-0.040
	(0.678)	(0.378)	(0.801)	(0.515)	(0.872)
Route-Km	-1.116*	-1.724***	-0.864*		
	(0.051)	(0.005)	(0.091)		
Trend	0.058***	0.041***	0.061***	0.067***	0.058***
	(0.000)	(0.007)	(0.000)	(0.000)	(0.000)
Fixed Price	0.380**			0.442**	
	(0.049)			(0.021)	
Cost Plus	-0.221			-0.147	
	(0.229)			(0.389)	
No Regulation	0.406**			0.327*	
	(0.031)			(0.059)	
NVI	-0.249*	-0.555***		-0.289*	-0.551***
	(0.095)	(0.006)		(0.050)	(0.007)
(Fixed Price)*NVI		0,708***			0,751***
		-0,006			-0,004
(Cost Plus)*NVI		0,04			0,089
		-0,921			-0,826
(No Regulation)*NVI		0,954***			0,677***
		-0,001			-0,006
Constant	6,262	-0,963	5,436	3,308	-4,309
	-0,478	-0,919	-0,59	-0,717	-0,657
Observations	133	133	133	137	137
Number of countries	10	10	10	10	10
R-squared	0.76	0.76	0.83	0.84	

Absolute p-value in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Structural Parameters

	Model 1	Model 2
r	1,00	1,00
ai	0,00	0,00
aL	0,01	0,50
aK	0,99	0,50
gamaL	0,61	2,42
gamaK	1,19	4,69

7 Appendix 1: description of accidents

The number of accidents were collected throught the Union the Chemin de Fer, a reference institution of the railway industry. The accidents are all related to the railways's operation, that is, they are associated with railway stock movements on open track or station premises. However, accidents that occur on the premises of workshops, warehouses and depots are not included.

The events defined as accidents are the ones that: (1) lead to the deaths of persons (instantaneous or within thirty days as a result of the accident) or serious injuries (involving temporary incapacity to work), excluding suicides and attempted suicides; criminal or natural death are excluded; (2) extensive damage of the stock, track or instalations (usually damages above ten thousands euros) or extensive disruption of the traffic.

The accidents are classified as collisions, derailments, accidents at level-crossings and other accidents. The collisions involve rolling stock units with others or an obstacle, excluding the case of level-crossing accidents. The 'other accidents' category includes fire or explosions. Each accident is counted only once, that is, if an accident at a level-crossing leads to an explosion, only the level-crossing accident is accounted, nothing being added in the 'other accidents' category.

Each accident cathegory was summed per railway operator per year in order to obtain an unique index of safety for each operator. Some of the sampled countries (Finland and France for the year of 1984) seemed to have changed their methodology accross types, so this operation prevented our estimations to be carrying our changes in method of accounting a particular type of accident.

8 Appendix 2: Further description of the regulatory regimes

The following tables present a tentative representation of the actual regulatory regime the railway passenger operators are subject to. The exercise was to double check the answer given by the countries to the OECD questionaire with the actual variables the respective regulator control and whether they have been performing accordingly.

In fact, the answer we have looked at was to the *Basis of Regulation* for passenger regulation. Starting from there, we went trought the ownership structure the industries in the respective countries, the licensing, the access rights and state financement to infrastructure. When the regime was not informed - case of France, Austria and Belgium - or had been presented as a mix of our two polar regimes - The Netherlands - the analysis of these variables became more relevant. The decisive variables were: limit of profits/revenues, ownership structure and deepness of reforms.

Our major sources were: Seabright et all (2002), ONU, IMPRINT, OECD, BOB (2003) and CER (2000).

Passanger regulation	Fixed Price			
	Denmark	Belgium	Netherlands	Sweden
Basis of regulation	Objective Benchmark	-	Objective Benchmark + Cost of Operator	Objective Benchmark
Liability for losses ?	Yes	No	No	No
Limit on Profit/revenue	No	No	No	No
Regulation of Prices	Yes	Yes	Yes	No
Regulation of Quality	Yes	Yes	Yes	Yes
Regulation of Quantity	Yes	Yes	Yes	No
Vertically integrated?	No	Yes	No	No
If vertically integrated,				
Separation of accounts?	-	Yes	-	-
When?	-	1997	-	-
If not vertically integrated,				
When?	1997		1988	
Infra is Public?	Yes	Yes	Yes	Yes
Name of Infra Manager	Danish National Railway Agency	NBMS(?)		BV
Operator is Public?	Yes	Yes	No	Yes
Name of Operator	DSB	SNCB	NS	SJ
Other operators?	Yes		y, few	Yes
Access Rights according to EC Directive 91/440?	Yes	Yes	Yes	?
AC fees EC ?				
State finance new infra?	Y + infra charges	Yes	y, 100%	Yes

Passanger regulation	No regulation		
	Finland	Germany	Spain
Basis of regulation	No Regulation	No Regulation	No Regulation
Liability for losses ?	No	No	Yes
Limit on Profit/revenue	No	No	No Regulation
Regulation of Prices	No	No	Yes
Regulation of Quality	Yes	No	Yes
Regulation of Quantity	Yes	Yes	Yes
Vertically integrated?	No	No	Yes
If vertically integrated,			
Separation of accounts?	-	-	No
When?	-	1994	-
If not vertically integrated,			
When?	1995		
Infra is Public?	Yes	Yes	Yes
Name of Infra Manager	Finish Railway Administration (RHK)	DB Netz AG	GIF
Operator is Public?	Yes	Yes	Yes
Name of Operator	Finish State Railway (VR)	DB AG	Renfe
Other operators?	?	y, many	No
Access Rights according to EC Directive 91/440?	Yes	yes, more abrangent	yes with restrictions
AC fees EC ?			
State finance new infra?	Y + infra charges	y via good loans	yes, 100%

Passanger regulation	Cost Plus		
	France	Italy	Austria
Basis of regulation	-	Cost of Operator	-
Liability for losses ?	Yes	Yes	-
Limit on Profit/revenue	-	No	-
Regulation of Prices	Yes	Yes	No
Regulation of Quality	Yes	No	Yes
Regulation of Quantity	Yes	No	Yes
Vertically integrated?	No	Yes	Yes
If vertically integrated,			
Separation of accounts?	-	Yes	Yes
When?	-	1998	1993
If not vertically integrated,			
When?	1997		
Infra is Public?	Yes	Yes	Yes
Name of Infra Manager	RFF		
Operator is Public?	Yes	Yes	Yes
Name of Operator	SNCF	FS	
Other operators?	y for international routes	y	
Access Rights according to EC Directive 91/440?	Yes	Yes	Yes
AC fees EC ?			
State finance new infra?	Y + infra charges	Yes	Yes

9 Appendix 3: descriptive statistics

Table 3a: Descriptive statistics of input prices

		Mean	Median	Maximum	Minimum	Std. Dev.
Austria	Wages	2,567	2,929	3,875	1,264	0,888
	Energy	0,001	0,001	0,001	0,000	0,000
Belgium	Wages	2,911	2,744	4,928	1,481	1,199
	Energy	0,001	0,001	0,001	0,001	0,000
Denmark	Wages	2,807	3,198	4,124	1,419	0,950
	Energy	0,001	0,001	0,001	0,000	0,000
Finland	Wages	2,187	2,416	3,061	1,166	0,684
	Energy	0,000	0,000	0,001	0,000	0,000
France	Wages	2,832	2,892	3,962	1,559	0,777
	Energy	0,000	0,000	0,001	0,000	0,000
Germany	Wages	2,563	2,662	3,751	1,397	0,760
	Energy	0,001	0,001	0,001	0,000	0,000
Italy	Wages	2,678	2,787	3,888	1,436	0,825
	Energy	0,001	0,001	0,001	0,001	0,000
Japan	Wages	3,426	3,532	5,760	1,586	1,318
	Energy	0,001	0,001	0,001	0,001	0,000
Netherlands	Wages	2,690	2,975	3,741	1,506	0,718
	Energy	0,001	0,001	0,001	0,000	0,000
Spain	Wages	1,937	2,165	2,583	0,856	0,523
	Energy	0,001	0,001	0,001	0,001	0,000
Sweden	Wages	2,895	3,054	4,003	1,531	0,829
	Energy	0,000	0,000	0,000	0,000	0,000
All Countries	Wages	2,676	2,691	5,760	0,856	0,934
	Energy	0,001	0,001	0,001	0,000	0,000

Table 3b: Correlations between variables

	Safety	Route-Km	GNI per Capita	Train-Km	Passengers	Population
Safety	1,00					
Route-Km	-0,37	1,00				
GNI per Capita	0,22	0,01	1,00			
Train-Km	-0,04	0,48	0,22	1,00		
Passengers	-0,44	0,82	0,23	0,67	1,00	
Population	0,02	0,64	0,05	0,83	0,56	1,00

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