

STOCKHOLM SCHOOL OF ECONOMICS
Master's Thesis in Finance

The Effect of Rail Deregulation on the Financial Performance of European Incumbent Operators

- A study of EU Railway Liberalization Process Impact

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Abstract

EU carries out three deregulation reforms, namely, separating accounting systems for infrastructure and operations, creating independent regulatory institutions and opening access to third parties, to increase the efficiency of European rail industry. We hereby explore its effect on financial performance of European incumbent operators, with the focus on the incumbents' efficiency as a result of different deregulation scenarios. We find that deregulation deteriorates incumbents' financial results, except for institutional separation of operation and infrastructure, which can be justified by its immediate offload of balance sheet for operation companies. Our results also suggest that firm characteristics play an important role behind financial performance.

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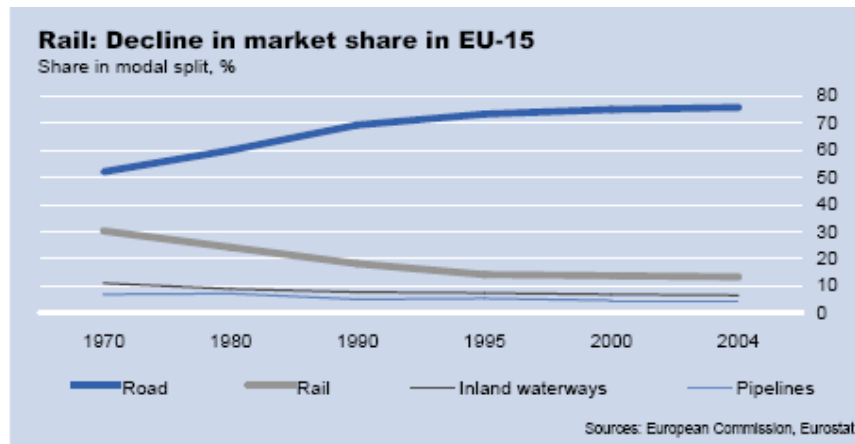
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1. INTRODUCTION

In the last few decades, European railway transport, as a mode of transportation in total traffic in Europe experienced an unsatisfying development. The relative share of rail transport continued to decline, compared to other transport markets (see graph below). This downtrend existed in both railway passenger and freight transport markets. Obviously, one of the main reasons is the fast development of other modes of transportation, e.g., the rise in motorization following World War II and the expansion of road infrastructure that went along with it. However, the traditional structure of railway transport in Europe, has contributed even more to the loss of the railway transport. Until some years ago, rail markets of the EU countries still had national monopolies dominated by the incumbents, i.e., state-owned rail operators who have been the owners of rolling stock, tracks and maintenance depots and are considered the specialists in the areas of production, operations, and maintenance, without market access for external providers. Even during the early phase of the liberalization (which we will introduce in the following paragraphs), the market share of new entrants is still very limited.

MARKET SHARE IN TRANSPORTATION MODAL SPLIT FROM 1970-2004



Sources: European Commission, Eurostat

1.1 LIBERALIZATION PROCESS AND THREE DEREGULATION REFORMS

In order to impede the downward trend of rail transport, EU and the member countries have been trying for years for the liberalization of railway transport market by taking various political measures. Since the early 1990's, the European Commission (EC), the legislative body in the European Union, has declared the development of the European railway system a priority for achieving sustainable development in Europe with the explicit goals of promoting railways, increasing their market shares, and reducing subsidies, and immediately began to

publish a series of White Papers to give impetus to the railway market. In one of the White Papers, the EC sets out very ambitious goals for the further development of rail transport in Europe by 2010, such as the strategy to ensure the relative share of rail as a mode of transport back to the 1998 level by 2010.

In addition, three deregulation reforms were drawn up one after the other in the EU Council Directives (91/440) to set up the liberalization schedule.

- 1) The first one is to separate accounting systems for the fixed infrastructure and rail operating equipment (e.g., to separate capacity allocation, track allocation, fee collection and licensing from transport services). Its aim was to guarantee the transparent and non-discriminatory access to rail infrastructure. In the years following, many European railways were split into track operating companies (e.g., NetRail in the U.K., ProRail in the Netherlands, and DBNetz in Germany), and separate passenger and railway freight transport companies (Haywood 2003).
- 2) The second one is to create independent regulatory institutions for railways, in order to improve safety and interoperability in European rail transport.
- 3) The third one is to open access to third parties, i.e., allow private railway transport operators to enter the European rail freight market and start competing with incumbents. The railway freight transport market was planned to fully open to competition before 2007, while the railway passenger transport market was planned to fully open not until early 2010.

With the liberalization, the share of the railway in freight and passenger transport in Western Europe has roughly stabilized at low levels most recently, whilst the relative share of railway in Eastern Europe is on a steady downward trend. Competition in freight transport has increased above all in EU countries where the market was opened early to all operators, e.g., United Kingdom, Germany and Sweden. In these countries, there are quite a few new entrants, albeit with a still limited market share. In contrast to these positive examples, there are many rail markets where the largest (incumbent) provider controls almost 100% of the freight market. This applies to countries such as France, Spain or Portugal. And even in the more open markets mentioned above, freight and passenger transports are dominated by the incumbent operators. Only in very rare cases is the market share of the largest supplier below 80% (e.g. in the United Kingdom) as per one research on competition in European railway market by Heymann (2006). By now, full-scale liberalization in European railway freight transport has been completed, and the further deregulation steps in passenger transport are on the way. However, that's not the end of the story. Although market entry is now possible for the private freight railway operators in all the countries participating in the liberalization, there is still no uniform situation. The legal requirement development process and practical market access processes, i.e., the two dimensions of liberalization, are developed at a

considerably different pace across countries. In some countries, the legal requirements are hardly developed at all by comparison, while the practical market access conditions have already reached an advanced stage of development. In other countries, however, the practical market access processes are not as well understood and developed as the legal requirements.

1.2 RAILWAY LIBERALIZATION INDEX

As mentioned above, the performance of European railway transport during the liberalization gives a mixed picture. In order to track the degree of market opening in the European railway transport markets, the Rail Liberalization Index (LIB Index) was created and has been developed into three editions since 2002. The latest edition was conducted in 2007 by IBM Global Business Services in collaboration with Professor Christian Kirchner, Humboldt University, Berlin, for and on behalf of Deutsche Bahn AG. The implementation of new framework conditions for the European rail transport market since 2007, in particular the complete liberalization of the railway freight transport market and the enlargement of the European Union made it necessary to conduct the third edition of LIB Index, which is also expected to further stimulate and enhance the process of liberalization of the railway transport markets in Europe.

For the purpose of having a comprehensive view on status quo of the two dimensions of liberalization in Europe, two sub-indices are derived from the LIB index, i.e., the LEX sub-index (law in the book) and the ACCESS sub-index (law in the action) to analyze and compare access conditions of the legal and practical market respectively,. It concentrates on a comparison of market entry costs such as labor, capital input. The LEX sub-index contains legal access conditions, such as regulatory authority competencies and the market access regime. The ACCESS sub-index contains practical access conditions, such as barriers to information, administrative and operational barriers, and in particular the share of the market that is accessible to private operators. The results included in the LEX Index account for 20 per cent of the LIB Index, with 80 per cent accounted for by the results included in the ACCESS Index.

In the Railway Liberalization Index 2007, all the examined countries are classified into three groups based on the degree of market opening achieved in terms of both legal and practical access. The three groups are namely “Advanced”, “On Schedule” and “Delayed”. Countries belonging to different groups may have quite different attitudes towards deregulation. There is no clue to indicate any correlation between being in a group and how long ago the liberalization started, whereas the degree of liberalization is quite different in the three groups.

Countries belonging to “Advanced” group have made considerable progress in terms of the degree of market opening achieved compared with the other European states. They have many years of experience with the market opening process, which has had a positive effect on the operational network access and regulation processes. They offer newcomers the best conditions in Europe. All the countries in this group have regulatory authorities with wide-ranging powers and competencies, and also with experience in dealing with complaints from private operators. The middle-ranking group - “On Schedule” - is currently going through a process of dynamic liberalization. However, different kinds of obstacles derived from each country’s own qualification obstruct this country moving forward to the advanced group. The reason can be either legal or practical or both. However, these markets still attract a certain amount of private operators to compete with incumbents. In the countries of the bottom group – “Delayed” –, both the legal and practical market entry barriers are the highest on a Europe-wide comparison. New entrants “normally” would experience a long authorization procedure to get valid licenses to run on state-owned tracks and also pay a relatively higher fee to run on them. Most private railway freight profit seekers can’t afford timing and financial risks to enter these markets.

In addition, the result of liberalization might also be quite different due to the different approaches chosen by countries, although the features of countries that belong to same group are in common.

1.3 STRUCTURE OUTLINE

After an overview of the whole liberalization process and three interrelated deregulation reforms is prearranged, we intend to capture the up-to-date index information and integrate it into existing UIC & World Bank datasets and draw imperative conclusions in an attempt to theoretically and empirically strengthen the foundation of the railway liberalization process.

The thesis is structured as follows. Chapter 2 further depicts our motivation and intended contribution to this field. In Chapter 3 we formulate our hypotheses based after review the previous research on related topic. Chapter 4 presents a detailed description of our dataset for both efficiency analysis and financial analysis, whereas our methodology is discussed and then economic specification is presented in Chapter 5. In Chapter 6 we interpreter our regression results on both country and incumbent level and then compare the efficiency across incumbents. More importantly, we explore the interrelation between efficiency and financial performance, deregulation and financial performance, different implementation approaches and financial performances as well as selected financial indicators and financial performances. In Chapter 7 a concise summary is given that refers to our initial questions. At last suggestions on further research are provided in Chapter 8.

2. MOTIVATION AND INTENDED CONTRIBUTION

Although the performance of European railway transport gives a mixed picture after the publication of the deregulation reforms, there is a strong belief among policy-makers that the three deregulation events can increase efficiency in the European railway market. This belief was validated and enforced by one study paper by Friebel, Ivaldi and Vibes (2004). In this paper, they investigated systematically to what extent the three deregulation reforms have affected railway performance based on the understanding of its determinants. They find that reforms of liberalization have positively affected railway productivity, while they are mainly interested in the efficiency of passenger transport.

In addition, by the time they did their study, neither has the new framework conditions for the European rail transport market been implemented nor has the liberalization of the railway freight transport market been completed. So as to reflect more comprehensive influence of the liberalization, we collect more updated data over time and across countries. We use an updated World Bank (2007) panel dataset which builds on data from International Union of Railways Statistics Database. We match this dataset with the information about deregulation reforms in these countries and look at the impact of the reforms on the efficiency in European railway transport market. Detailed data description can be found in Chapter 4 “The Data”.

It might be challenged that there is rarely the case to have enough cross-country variation and variation over time to disentangle reform effects from other influences. We believe that, however, it is possible to identify the impact of regulatory regimes on railway performance, because different countries have implemented the reforms to different degrees and at different times.

We also try to qualify and reflect the impacts from economic perspective via introducing the concept of financial performance and three financial indicators, i.e., long-term debt/asset (leverage ratio), $\ln(\text{assets})$ and Capex/Sales. We pre-define the correlation between the three indicators and ROA respectively, and use ROA as the measure of financial performance to capture whether deregulation reforms will stimulate incumbents' financial performances.

What's more worthy to point out here is that we link efficiency with financial performance and conclude from our analysis that the way deregulation contributes to the relationship between efficiency and financial performance.

From the model construction perspective, we also have two improvements based on the previous studies, as follows,

- 1) We build up relative efficiency comparison from solely on passenger services to at both freight service level and total service level. We can compare the liberalization

effect on freight and total efficiency respectively with an intention to elaborate how each incumbent react according to its own legal and competition environment.

- 2) We choose to use the implementation time of market access as opposed to the enactment time of the legal requirement as the starting point of the time period. The reason for this change is to avoid the possible difference, lags in most cases, between the practical implementation time and legal enactment time. We believe that the implementation time is more related to the efficiency change than “law on book” time, considering the possible time lags between the two points of time. This is also a further research part mentioned in Ivaldi et al (2004): “We have to date only been able to look at reforms in the law book, and cannot control for different types and intensity of implementation. Better data are needed to come to a final conclusion about the effect of different policies solution for the deregulation of railways.”

The aim of this thesis is to investigate how the three deregulation reforms have affected the European railway transport market. Besides understanding the overall effect of the deregulation, we also examine the marginal impact of each deregulation event on the European railway transport market by comparing the impact of implementing the three reforms sequentially as opposed to as a package. Last but not the least, we introduce the three financial indicators and try to measure whether the deregulation will stimulate the incumbents to improve their financial performance. We hope our findings can contribute to the field of research for the further analysis on the competition and development in the European railway market.

3. HYPOTHESES

Few studies are known on the effects of rail deregulation on efficiency. As mentioned previously, we are however inspired by Ivaldi et al (2004), who compare the passenger traffic efficiency of railways using production frontier approach and it turns out to be a good starting point for us to understand the impact of deregulation on railway efficiency and smoothes our further investigation for some reason. First of all, when applying the production frontier model, they make a good attempt to control for the effect of freight traffic on passenger traffic and allow for the aggregation of outputs. Second, they define efficiency through model residual, which captures the part of the output for country i at time t that cannot be observed by the production function. They rank all countries at time t by residuals and measure total efficiency of all countries relative to the most efficiency one. Furthermore, they construct four different sets of reform variables in order to see systematically to what extent reforms have affected railway efficiency in a positive way and how it happens. Last but not least, this study applies the LISREL method to test the results robustness against potential problems of endogeneity. The results show that the introduction of reforms has positive effect on efficiency, but this effect depends on sequencing: introduction of multiples reforms in a package has negative effects, while sequential reforms improve efficiency.

Lalive and Schmutzler (2007) study the effects of competition for railway markets in the German state of Baden-Württemberg. The findings are, after controlling for line characteristics, the lines that were procured competitively have achieved a higher growth of the frequency of service.

Caves, Christensen and Swanson (1981) investigate how the level of regulation affects economic performance by comparing that in U.S and Canadian railroads. The results indicate that, given that natural conditions are in favor of U.S railroads, the more regulated U.S. railroads have shown a significantly lower productivity than have Canadian railroads.

In terms of the effect of railway efficiency on corporate performance, we are not aware of any relevant research. However, the empirical literature investigating other determinants of firm performance gives us great guidance.

Adams, Almeida and Ferreira (2005) examine the relationship between founder-CEO status and corporate performance. In order to do that, they control for organizational variables, such as the degree of diversification (the number of different two-digit SIC segment codes), firm size (natural log of assets), firm age (number of years since date of incorporation), leverage (book value of long term debt divided by book assets), capital expenditures over sales, and two-digit-SIC industry dummies. They find that firm performances are more variable if their CEO has more decision-making power and the above mentioned organizational variables have important impact on corporate performance.

Therefore we try to control organizational variables when studying the correlation between railway efficiency and firm performance.

As summarized above, existent research and ongoing liberalization process make us like to further investigate what and how the deregulation process impact the status quo of the European freight railway market. Therefore, four hypotheses can be formulated to capture most of the characteristics behind the process. An outline of our hypotheses is listed below:

3.1 POSITIVE IMPACT ON INPUT-OUTPUT PRODUCTIVITY OF COUNTRIES

As mentioned previously, the finding in the study of Ivaldi et al (2004) indicates that the implementation of deregulation reforms leads to higher railroad input-output productivity on country level. The process brings in new profit-driven entrants, thus will haul up the competition level. In this case, it will in the end benefit their input-output productivity. We therefore deem that the whole deregulation process has a positive effect on input-output productivity of countries.

Deregulation process will have a significant impact on input-output productivity of incumbents. Incumbent used to be subsidized by countries, and with the least intention of market share being nibbled, incumbents would try to optimize its input-output ratio to cope with more and more competitive environment during the process. However, we expect this optimization process to be hysteretic to deregulation events in big countries due to incumbents' massive structure. On the other hand, it's hard to foresee its impact on small countries due to their remaining unchallenged rulership in the first few years after deregulation. Therefore, we cannot ex ante predict whether the effect is positive or negative, however, we expect it to be significant.

Hypothesis 1a: The liberalization process improves input-output productivity of countries.

Hypothesis 1b: The liberalization process significantly impacts input-output productivity of incumbents.

3.2 INPUT-OUTPUT PRODUCTIVITY IMPROVEMENT COMPARISON

It can be presumed that all private operators are proactive to ameliorate themselves according to the new legislation before they enter the open market in terms of staff allocation; cost structure optimization and operational route selection whereas incumbents are almost passive takers of directives. Even if they would have foreseen the changes, huge organization

structure, mandatory running routes and other negative elements of national monopolist would slow down the input-output productivity improvement progress. Hence we consider in a considerably competitive country:

Hypothesis 2a: Private operators increase their input-output productivity faster than incumbents do.

Hypothesis 2b: Private operators are the main driving force of input-output productivity improvement on their located countries.

3.3 DIFFERENT WAYS OF DEREGULATION IMPLEMENTATION

Not as similar as one might think, each European country has its own railway system in term of technical parameters (rolling stock parameters, track parameters and signaling parameter). The easiness of homologation differs from country to country. Also various attitudes of every government towards deregulation have direct effects on the level of development of implementation. Some countries like Spain and Italy apply reciprocity principle while Sweden does not. Therefore, here we believe the efficiency improvement and financial performances of incumbents depend on how deregulation events were conducted in this country. Our intuition is that more than one events conducted is more excitant than only one implemented. If more than two, then a sequential approach is less demanding for incumbent to absorb in terms of operation optimization and also leaves some time between events let investment spent exhibit its effect to return. Ivaldi et al (2004) statistically assert that sequential reforms have achieved higher efficiency whereas reforms carried out in a package deteriorate it. The legal entity split of infrastructure company offloads operator's weighty fixed assets and in turn literally may have a positive effect on ROA.

Hypothesis 3a: More than one deregulation events implemented has stronger positive correlation with efficiency and ROA compared to only one deregulation event conducted.

Hypothesis 3b: Sequential Deregulation has stronger positive correlation with efficiency and ROA compared to a single deregulation package.

Hypothesis 3c: Institutional separation of incumbents has stronger positive correlation with efficiency and ROA compared to organizational separation.

3.4 HOW DOES LIBERALIZATION INFLUENCE FINANCIAL PERFORMANCE

As a profit-driven corporation, the most relevant question after its efficiency enhancement must be whether this improvement helps to make more profits for the company? To answer this question, we control for some firm characteristics, i.e. $\ln(\text{asset})$ as a proxy for firm size, long-term debt/assets as leverage ratio, and Capex/Sales.

We expect efficiency increase leads to higher operating income, thus higher return and higher ROA. However, similar as hypothesis 1b, the translation process from efficiency on operational level to ROA in monetary term is expected to be slow. Therefore we consider the efficiency increase itself wouldn't bring immediate higher profit to the incumbents.

Hypothesis 4: Incumbent's efficiency index is correlated with its ROA

4. THE DATA

Our primary sample consists of data on eight EU countries/incumbents: Austria/ÖBB, Belgium/SNCB, Denmark/DSB, Finland/VR, Germany/DB AG, the Netherlands/NS, Portugal/CP, and Sweden/SJ.

For some companies, part of the operations was sold or new companies were created to take responsibility of part of the operations during the estimation time period. DSB Cargo was sold in 2001 to Railion creating Railion Denmark. Green Cargo, created from SJ in 2001, is responsible for freight transportation while new SJ takes the passenger part. NS Cargo merged into Railion in 2002 and became Railion Benelux. In 2003 this name was changed again into Railion Nederland. In such cases we combine data of both companies since the year of happening.

Table 2 in Appendices shows deregulation reforms. It reports the year in which deregulation reforms were implemented. Data are obtained mainly from OECD (2006) and IBM (2007). We have done our own investigation on the internet also.

4.1 EFFICIENCY ANALYSIS

To compute efficiency index, we use data covering 1980-2005. Country-level data is from World Bank Railway Database 2007 and firm-level data is obtained from International Union of Railways Statistics Database.

In measuring output, rail analysts have long recognized that freight service has weight and distance components. These are reflected in the number of tons loaded and the distance over which the tons are hauled. Similarly, the components of passenger service are the number of passengers carried and the length of the trip. Two good candidates for such measures would be passenger kilometers and freight tonne kilometers.

In Table 1 of Appendices, Panel A and Panel B present summary statistics concerning selected variables.

4.2 FINANCIAL ANALYSIS

We explore the incumbents' financial performance by using return on assets (ROA) to capture whether efficiency index impacts firm performance, and define ROA as the ratio of net income to total assets. Apart from efficiency index, we control for the natural log of total assets as a proxy for firm size, leverage defined as long-term debt divided by total assets and capital expenditure over sales (Capex/Sales).

We expect larger firm to be more stable in delivering financial results. Besides, we consider that the efficiency increase would stimulate incumbent to finance its assets by one way or another, which is an interesting issue and Pecking Order Theory developed by Myers and Majluf (1984) is behind the story. The theory asserts that companies would start with debt and leave equity as a last resort, due to the costs of asymmetric information, to specify, there is positive signaling associated with debt while negative signaling to the stock market associated with issuing equity. However, more heavily financed by debt, it indicates greater risk, which has negative impact on profitability. Due to the hysteresis effect of the capital expenditure in generating sales in operational level, we expect Capex/Sales negatively affects the ROA of incumbent operators.

It hypothesizes that efficiency index would affect accounting performance together with other firm-level characteristics:

$$ROA = \rho + \rho_1 Efficiency + \rho_2 \frac{Capex}{Sales} + \rho_3 Leverage + \rho_4 Ln(Assets) + (\delta_i + \tau_0 Deregulation_{it})t + \omega_{it} \quad (1)$$

Data are obtained from firms' annual reports from 2002 to 2005 and Table 1 Panel C in Appendices presents summary statistics of financial variables.

5. EMPIRICAL STRATEGY

5.1 METHODOLOGICAL REMARKS

In order to compare the efficiency of Decision Making Units (DMUs), two theoretical approaches are available in the current literature. One is the parametric, which economists usually look at, to construct a parametric frontier based on an estimation of the characteristics of the functions under a behavioral maximization hypothesis. This is usually a production frontier, a cost frontier, or a profit frontier. The other one is non-parametric technique which is known as Data Envelopment Analysis (DEA).

DEA has the advantages of clearly identifying the frontier units and easily dealing with multiple outputs. However, it does not provide a single functional form to model the efficient frontier. Simar (1992) points out that “a parametric form for the production function allows for a richer economic interpretation of the production process”. Moreover, DEA is deterministic, and doesn’t allow for statistical inference and is consequently unable to distinguish between inefficiency and statistical noise.

Parametric techniques can be either stochastic or deterministic. With stochastic frontiers, not the whole amount of the observed performance falls behind the maximal one is measured as inefficiency. On the other hand, it uses a composite error term to capture both statistical noise and inefficiency. In this case, however, a specific distribution must be known a priori for this composite error term before the model can be set up.

In the deterministic frontiers, a given functional form asserts the maximum output from a given technology progress and combination of inputs. Inefficiency is then measured by the deviation of the observed output from the maximum one.

Railway transportation uses various inputs to produce a multiplicity of outputs, e.g. passenger services and freight services while the production function presumes a single homogeneous output. A common procedure in the study of multiproduct firms is to use a single variable to represent output, no matter how diverse are its actual components, which is almost universally adopted in empirical production studies. However, it has been recognized that its implication is highly restrictive. An early contribution to empirical methodology for modeling multiproduct firms was made by Klein (1953). He proposed a model which allowed for separability between outputs and inputs and the output and input functions both had the Cobb-Douglas form. Caves, Christensen and Brown (1979) made a further attempt to relax the assumptions of separability and homogeneity by the use of a flexible multiproduct cost function.

As the deterministic parametric approach serves as a convenient way to relate outputs to inputs, and measure the effect of inputs and/or outputs on efficiency for any particular

production combination, we will adopt it in our research. We also attempt to clean up the statistical noise, which will be explained further in this chapter.

5.2 ECONOMETRIC SPECIFICATION

The estimation of production function is simple and advantageous in the analysis of regulatory process of any industry. Cobb-Douglas implies a priori separability between inputs and outputs. In our framework, we estimate an aggregate output multi-inputs production function using the Cobb-Douglas technology, which in logarithmic form is linear in parameters:

$$Y = AK^{\alpha_K}L^{\alpha_L} \quad (2)$$

where Y is total production, L and K are, respectively, labor and capital input, and A is total factor productivity. α_K and α_L are the output elasticities of capital and labor, respectively and the sum of those determines returns to scale. Returns to scale measures changes in output following to a proportional change in inputs and we refer to it when we investigate input-output productivity.

In this study we take it as the aggregated summation of Passenger Kilometers and Freight Tonne Kilometers. The labor input in the production process is staff (L).

We aimed to construct the measure of capital input on the basis of information on land, buildings, rolling stock, other machinery and equipment, and construction in progress, obtained from the firm's annual reports and proceed as follows: We started from the firms' recent reported figures (2006) of capital, solved $K_{i,t-1}$ from $K_{i,t-1}(1-d_i) + I_t = K_{i,t}$, where $K_{i,t}$ is capital of category i , I_t is investment of rolling stock from production side, and d_i ¹ is depreciation rate of category i . We wanted to see how well the investment in rolling stock approximates the investment in capital, and this revaluation of capital approximates balance sheet capital. However, confined by the time scope of investment that we have (1997-2005), by which most of our target countries had implemented at least one out of three deregulation reforms, the results were neither expected nor significant.

Indeed, the reliable capital input measure available is route kilometers (K). It measures the length of lines of the railway.

Referring to Ivaldi et al (2004), we specify Cobb-Douglas product function as follows:

Written in natural logarithms, equation (2) becomes:

$$\ln Y = A + \alpha_K \ln K + \alpha_L \ln L \quad (3)$$

For country/incumbent i at time t , A can be defined as:

$$A_{it} = \alpha + u_{it} + \varepsilon_{it} \quad (4)$$

¹ Depreciation rates are obtained from companies' annual reports in 2006. We take it 5%, 5% and 12.5% for buildings, rolling stock, other machinery and equipment, respectively. There is no depreciation on construction in progress.

We see u_{it} as the inclusion of country/incumbent fixed effect and deregulation effect, both interacted with time, expressed as

$$u_{it} = (\gamma_i + \theta_o Deregulation_{it})t \quad (5)$$

We define $Deregulation_{it}$ to be one if a country has implemented any earliest reforms out of three, and zero otherwise.

As we apply a panel data set and enough observations, accounting for the country/incumbent fixed effect multiplicative with time, instead of country/incumbent and time separately, helps to model time-varying unobservable for each country/incumbent and therefore wipe off a lot of statistical noise in the data.

We have also tried another set of control which uses interaction between country fixed-effect and deregulation effect, not multiplicative with time. The result doesn't differ much and we have reported it in Table 5 and Table 7 in Appendices.

Incorporating equations (4) and (5) into (3), we get

$$\ln Y_{it} = \alpha + \alpha_K \ln K_{it} + \alpha_L \ln L_{it} + (\gamma_i + \theta_o Deregulation_{it})t + \epsilon_{it} \quad (6)$$

As mentioned previously, we are mainly interested in the efficiency of freight transportation. So we try to estimate how capital and labor are allocated between the production of passenger traffic and freight traffic by looking at the following equation:

$$\ln Y_{it} = \ln Tonnekm_{it} + \lambda \ln Passkm_{it} \quad (7)$$

We obtain λ by estimating

$$\begin{aligned} \ln Tonnekm_{it} = & \beta + \lambda \ln Passkm_{it} + \beta_K \ln K_{it} + \beta_L \ln L_{it} \\ & + (\varphi_i + \theta_o Deregulation_{it})t + \mu_{it} \end{aligned} \quad (8)$$

λ in equation 7 equals to 0.555 at country level and 0.408 for incumbents, which means if production of passenger traffic increases 1%, production of freight traffic decreases on average, 0.564% for target countries and 0.466% for incumbents accordingly.

As the choice of Freight Tonne Kilometers simultaneous with that of Passenger Kilometers, there is a potential problem of endogeneity. Ivaldi et al (2004) verify this correlation between variables using the LISREL ("Linear Structural Relations") and conclude that this type of correlation is insignificant. Referring to this study we therefore think the results of our regression are unbiased.

5.3 RELATIVE PRODUCTIVITY EFFICIENCY

Here we also formally introduce a relative efficiency index used to compare across incumbents' productivity performance. In the regression result, we can only justify the general trends of deregulation implementation on countries and incumbents but not particularly the consequence on a single country or a single incumbent. Does the implementation process immediately correlate to a certain country's efficiency? Or it takes

some time for a certain country to digest, if this is the case what's the rationale behind it? In what follows we construct the relative efficiency measurement and also employ this methodology to discuss the result.

5.3.1 Total Relative Productivity Efficiency

The equation as following:

$$Eff_{it} \equiv \exp(\epsilon_{it} - \epsilon_t^{max})$$

where ϵ is the residual of our model as equation (6). Following Ivaldi et al (2004), we measure total productivity efficiency through the residual. Using the parameter estimates from the regression results, together with the logarithms of the observed value of capital and labor, the value for deregulation and the time for each country/incumbent, we can calculate the estimate of the logarithms of the output for country/incumbent I at time t . Deducting it by the observed value for the specific country/incumbent, we get the model residual.

The residual captures all the elements we haven't modeled. We deduct residuals of country/incumbent I by maximum residuals among all countries/incumbents in year t to measure total relative productivity efficiency. Furthermore, the result can be unitized by applying an exponential form.

5.3.2 Freight Relative Productivity Efficiency

The equation can be seen as following

$$FreightEff_{it} \equiv \exp((\epsilon_{it} - \epsilon_t^{max}) + \lambda (\ln Passkm_{it} - \ln Passkm_t^{max}))$$

where, on the right-hand side, the first part indicates the total traffic relative productivity efficiency. We deduct it by a negative adjustment of passenger efficiency and apply it in an exponential form.

5.4 COUNTRY FIXED EFFECT

In order to see whether efficiency affects incumbents' financial performance, apart from the firm-level characteristics, we also include country dummies to capture unobserved country specifics. We reject the null hypothesis that country fixed-effects are jointly equal to zero and therefore conclude the country fixed-effects contribute to the correlation between efficiency and financial performance. Results are presented in Appendices Table 11, Table 14, Table 17 and Table 20 for Scenario 1 to Scenario 4 accordingly.

6. ESTIMATION RESULTS AND ANALYSIS

In this chapter, we report our empirical findings in the following order. First of all, we examine whether deregulation has a positive correlation with country railway input-output productivity in general, followed by a similar model but with incumbents' data. Here we expect the input-output productivity of incumbents will be substantially impacted. Given that private operators tend to have first-mover advantages and more flexible configuration when markets get deregulated, larger aggregate coefficients of inputs (labor and capital) will be found in country model. Secondly, we construct relative total productivity efficiency and freight productivity efficiency (will be formally introduced in the coming section) across incumbents to discover efficiency changes incumbent to incumbent. By this method we can also investigate the evolving pattern of a single incumbent according to its particular actual legal and operational environment. Thirdly, a certain incumbent's efficiency change can also be a result of the way the deregulation process was conducted in that specific country. We disentangle the deregulation variable to three different sets of variables to determine which deregulation strategy has a more significant impact on incumbents' efficiency performances. Next we use the financial information available on each incumbent to examine to which extent their performance (as measured by Return on Assets) can be explained by financial elements. Moreover, the interaction between these financial variables and the way deregulation was conducted is also a critical consideration, which will be regressed and analyzed in the end.

6.1 SCENARIO ANALYSIS

As mentioned above, various ways of deregulation conducted can potentially have different correlations with incumbents' operational and financial performances. For instance, is an entire package approach taken by governments too intricacy for management of incumbents to handle and on contrary has a minus effect on its normal operations? Is an institutional spin-off of infrastructure clearing off incumbents' heavy balance sheet and then boost its financial performances? Therefore apart from a general deregulation effect model, we also introduce three deregulation dummy variables to reflect three different ways of deregulation events conducted in our efficiency and financial model. In addition, in all four scenario models, country fixed effect variables will also be added with an intention to enhance the exactitude.

In each scenario, we have three sub-sections. First of all, we analyze the regression results and find out how three deregulation events impact input-output productivity at both country level and incumbent level. Secondly, we compare relative total and freight efficiency across incumbents. Thirdly, we explore how a certain deregulation event contributes to

incumbents' financial performances and what is the relationship between efficiency and financial performance. A summary table of all scenarios is provided for clear overview.

TABLE 1 REGRESSION SCENARIO SUMMARY

Scenarios	Interpretation	Input-Output efficiency model		Relative Efficiency Comparison	Financial Model	
		No FE	FE		No FE	FE
1	<i>Dereg_t</i> valued 1 when any earliest deregulation events has been implemented out of three and 0 otherwise	No FE	FE	Yes	No FE	FE
2	<i>Dereg_One_t</i> valued 1 when only one deregulation event is implemented in the located country and 0 otherwise. <i>Dereg_Two_t</i> valued 1 when two or more events are conducted and 0 otherwise.	No FE	FE	Yes	No FE	FE
3	<i>Dereg_Sequ_t</i> valued 1 when one reform is implemented at a time and followed by others, and 0 otherwise. <i>Dereg_Pack_t</i> valued 1 when more than one reforms are implemented at the same time, and 0 otherwise.	No FE	FE	Yes	No FE	FE
4	<i>Dereg_Org_t</i> is valued 1 when countries/incumbents that choose organizational separation have implemented and maintained and 0 otherwise. <i>Dereg_Ins_t</i> is valued 1 when institutional separation happened to the countries/incumbents that opt for, and zero otherwise.	No FE	FE	Yes	No FE	FE

Note: No FE means Regressions without Country Fixed Effects. FE means Regressions with Country Fixed Effects

6.1.1 Scenario 1: The Effect of Deregulation

6.1.1.a Regression results

In this model, we follow methodology of Ivaldi et al (2004) that for *Dereg_t* value one is taken if any earliest deregulation events has been implemented out of three events and zero otherwise. By doing this, we presume that after several years of legal preparation, the first effectual implementation will shockwave the whole industry and change input-output productivity status quo drastically.

Regression results of our first are shown in Appendices Table 4I&6I. The R-squared values are very high (0.98 and 0.97) and most parameters are significant at the 1% level, except for Germany & Portugal in the country model and Deutsch Bahn in the incumbent model.

Sum of parameter estimates of labor and capital in country and incumbent model are respectively:

$$\text{Country: } \alpha_{\text{capital}}(0.764) + \alpha_{\text{labor}}(1.108) = 1.872 > 1$$

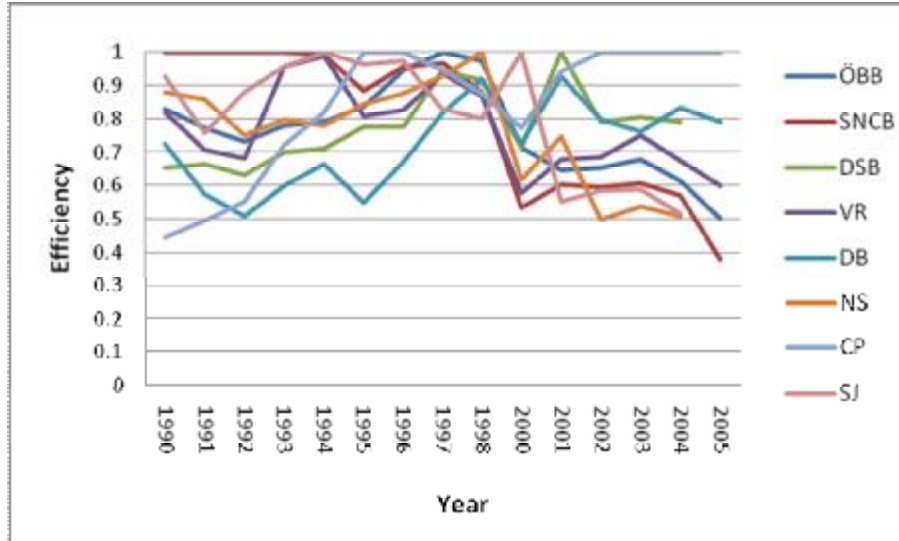
$$\text{Incumbent: } \alpha_{\text{capital}}(0.628) + \alpha_{\text{labor}}(1.144) = 1.772 > 1$$

The remarkable increasing returns to scale uphold our presumption and also note that all countries productivity trends are positive. It is noteworthy that return on country model increase slightly faster than return on incumbents level. Therefore in general the deregulation improve the railway input-output productivity both and country level and incumbents level, which supports our first set of hypotheses. However, the incumbents' relatively low increasing returns compared to entire countries' indirectly indicate that the effect of reform is larger on private operators than on incumbents, which is in favor of our second set of hypotheses.

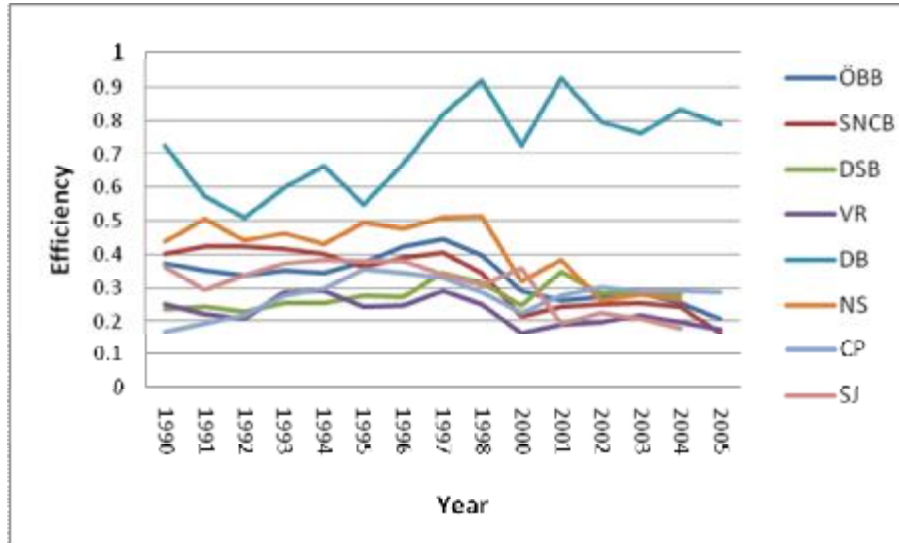
6.1.1.b Relative efficiency comparison

We omit efficiency index of 1999 in all graphs due to missing data. Detailed efficiency index figures can be found in Table 8 of Appendices.

GRAPH 1A INCUMBENT TOTAL RELATIVE EFFICIENCY TREND (MODEL 1)



GRAPH 1B INCUMBENT FREIGHT RELATIVE EFFICIENCY TREND (MODEL 1)



We can see from Graph 1A that the national operator of Portugal, CP stays highest relative efficiency after deregulation begins. This is somehow surprising due to limited market potential of Portugal (not centered in European freight corridor) and CP's monopoly status². A further investigation would be made afterwards to find rationale behind. However, the same graph also indicates that most incumbents like SNCB, NS and SJ extend their gaps to the highest efficiency whilst DSB and DB fluctuate but still stay at a relative high efficiency level. VR, the monopolist in Finland nevertheless increases its relative efficiency 2000 subsequent to an efficiency plummet between 1996 and 2000 when the deregulation first implemented in Finland dating back to 1995. It illustrates that without third-party competitive stimulation, it takes some years for the incumbent to adjust itself to the new regulations.

When we look at Graph 1B, solely plotting freight efficiency, the obvious efficiency leader is Deutsch Bahn in Germany, which is the biggest import/export country in Europe. DB separated its cargo business (Railion) at early 90's to compete with emerging private operator. After several years of ebb and flow, Railion operates at a relative high efficiency level, which outperformed other incumbents' freight arms to a great extent.

6.1.1.c Financial performance

Furthermore we investigate our financial performance models with and without country fixed effects. In all models, leverage ratio is the only significant financial variable (all significant at 1% level). The second common pattern is the substantial increase of R-squared whenever leverage ratio is included (from approx. 0.3 to 0.8). Thirdly, country fixed effects add validity

² As of 2007, CP is still the only railway operator in Portugal, but currently there are two external private operators applying for access to Portuguese network.

to our model by increasing r-squared considerably. Hence we deem model with county effects as our main observation and leverage ratio as our key variable.

We note that all leverage ratios have negative coefficients significant at 1% level, which indicate that every time there is 1% increase in leverage ratio, there is approximately 0.2% decrease in ROA. Our argument is that when national railway operators raise new debt to invest in purchasing new train units/locomotives, building or upgrading maintenance facilities and upgrading tracks to high-speed railway needs, these investments can bring higher return spreading in a long scale of time (30+years) instead of having a skyrocketing return in next few years. However the denominator, total asset increase drastically as from the year incumbents accomplish these investments, which lead to a negative related return on assets.

Moreover, insignificant efficiency indices and deregulation variable can also be found in all models. At this stage no solid reasoning can be presented, then we include different deregulation dummies used before (one aspect vs. two aspects; sequential vs. package and organizational vs. institutional) to further investigate the rationale behind.

6.1.2 Scenario 2: One-Aspect vs. Two-Aspects Deregulation

6.1.2.a Regression results

Since the first regression only counts the impact of the first implementation of three events, subsequently, we want to investigate if the result will be further strengthened by including two or more events implementation. To accomplish that, two dummy variables are applied our second model, *Dereg_One_t* takes value one when one and only one deregulation event has been implemented and zero otherwise. *Dereg_Two_t* takes value one when two or more than two deregulation events have been implemented and zero otherwise.

From Table 4II&6II in Appendices, results of our second regression model do not show notable variation from the first model. The returns to scale and productivity trends are more or less still in the similar range with subtle differences.

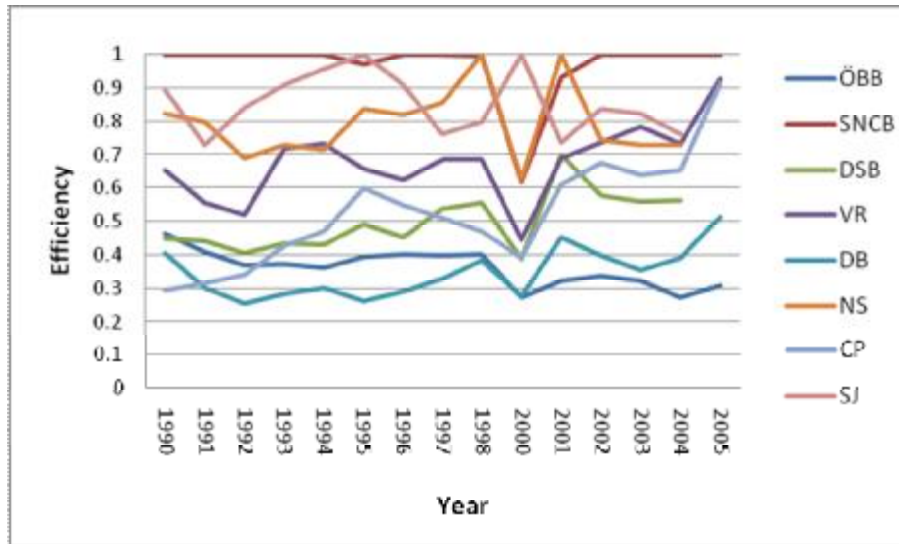
$$\text{Country: } \alpha_{\text{capital}}(0.757) + \alpha_{\text{labor}}(1.106) = 1.863 > 1$$

$$\text{Incumbent: } \alpha_{\text{capital}}(0.627) + \alpha_{\text{labor}}(1.138) = 1.765 > 1$$

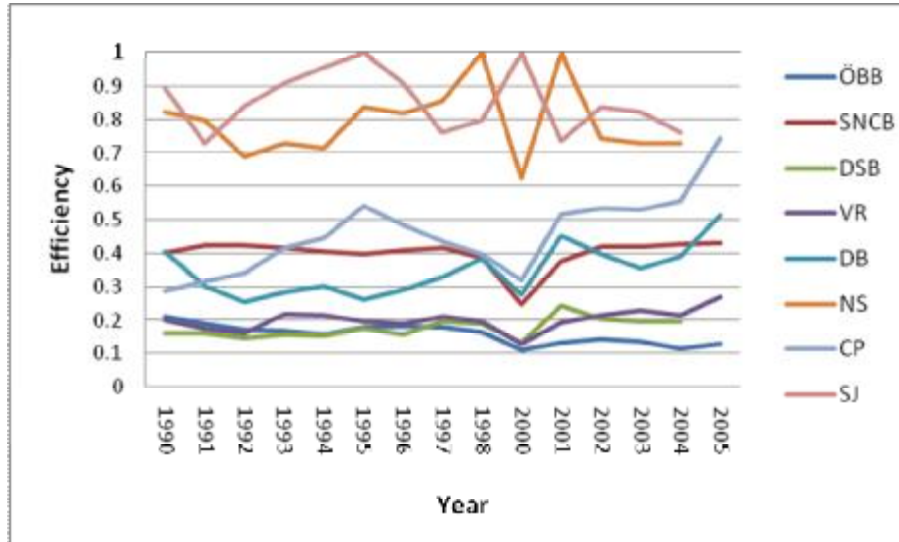
The results essentially do not surprise us so much since also in other industry liberalization process, when legal provisions come to real life practice, the significance of the first events on its own could make structural changes to the whole industry while the sequential directive packages can only be quantitative elements consolidating the outcome position.

6.1.2.b Relative efficiency comparison

GRAPH 2A INCUMBENT TOTAL RELATIVE EFFICIENCY TREND (MODEL 2)



GRAPH 2B INCUMBENT FREIGHT RELATIVE EFFICIENCY TREND (MODEL 2)



In Graph 2A, most incumbents had a dip in 2000 except for SJ in Sweden. We deem it as outcome of the carve-out activity done by SJ in 2000. The logistic division of SJ is separated and created a new railway freight company green cargo in 2000. SNCB of Belgium tops in total efficiency comparison whereas is below average in freight efficiency. This pattern reasonably illustrates Belgian railway status quo as a central hub of passenger service but not of freight service. SNCB concentrates on its high-speed railway development (partnership with SNCF, NS and Virgin UK improving fast connection to Paris, Amsterdam

and London), neglecting cargo related improvement after liberalization. Other incumbents show fairly coherent efficiency pattern in Total and Freight.

6.1.2.c Financial performance

In models without country fixed effect, another financial variable Capex/Sales turns significant together with continued significant Leverage ratio but our two new dummy variables are insignificant. Efficiency index turns significant ever and again in models with lower R-squared. We also notice that the inclusion of leverage ratio raise the R-squared drastically. We further regress the model with country fixed effects and discover generally higher R-squared, which make these models more compelling.

Nevertheless, insignificant results of Capex/sales variable are found this time even together with leverage ratios, whose coefficients are increased and remain significant at 1% level. And all efficiency indices are significant as long as leverage ratios are incorporated. Same pattern can be found on the deregulation dummies, which tend have negative effects on ROAs. Moreover, two aspects deregulation dummies all have larger absolute parameter values. This result together with the negative coefficients of efficiency indices indicate that the efficiency increases of incumbents conversely deteriorate incumbents' profitability and more deregulation events were implemented, worse incumbents' financial performances were. Therefore, we reject Hypothesis 3a.

6.1.3 Scenario 3: Sequential vs. Package Deregulation

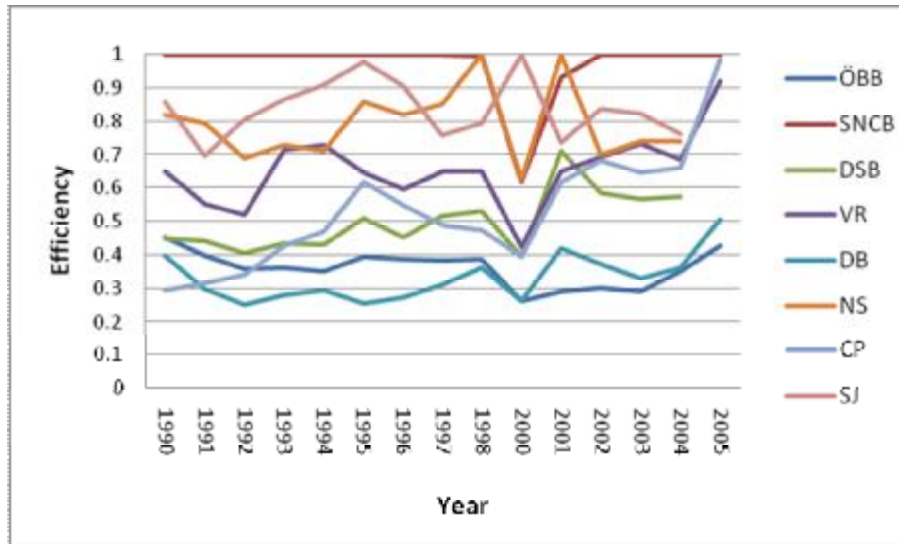
6.1.3.a Regression results

On the other hand, another motivating perspective are different ways each country implements those deregulation packages: the implementing timeline is adjusted sequentially according to the feedback from outcomes or the government just without further ado execute three packages together? From this starting point we constructed our third model with two dummies: *Dereg_Sequ_t*, which is valued one when one reform is accomplished at a time and followed by others, and zero otherwise. *Dereg_Pack_t*, which is valued one when more than one reforms are implemented at the same time and zero otherwise.

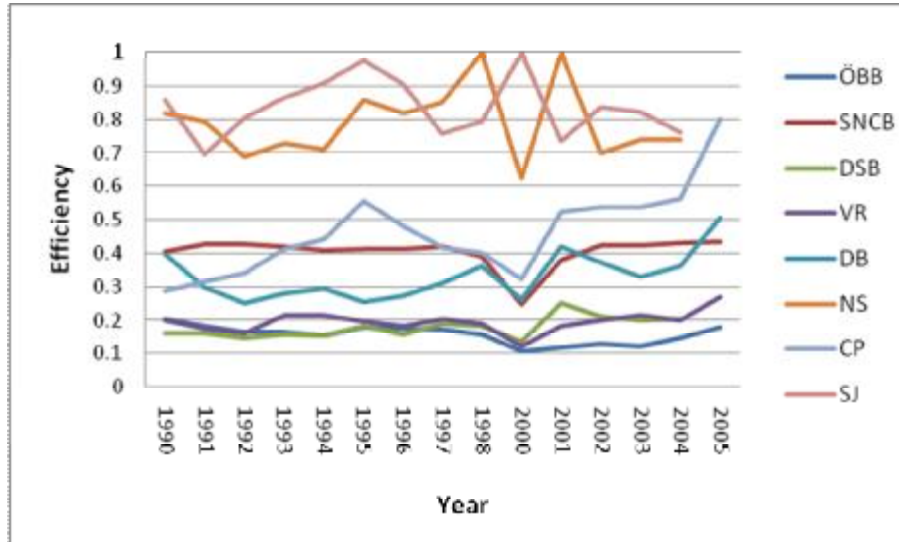
Some interesting findings can be scrutinized in Table 4III & 6III of Appendices, which contains results from our third model. The returns to scale are still similar to previous two models and all significant productivity trends of countries/incumbents are still positive, but we have insignificant negative parameters of *Dereg_Pack_t* in country model (-0.009) and in incumbents model (-0.012). It seems that a sequential package is easier for countries and incumbents to digest. In another sense, it's also sensible that time and gradual changes are needed for long existing national railway operators to fiddle with the new competitive environment.

6.1.3.b Relative efficiency comparison

GRAPH 3A INCUMBENT TOTAL RELATIVE EFFICIENCY TREND (MODEL 3)



GRAPH 3B INCUMBENT FREIGHT RELATIVE EFFICIENCY TREND (MODEL 3)



Similar dummy regularity between model 2 and 3 causes comparatively analogous pattern as previous one. Still ÖBB took in sequential deregulation event in 2001 and 2004 and experienced increases in total efficiency whereas CP received package deregulation event in 1997 and immediately dropped by 0.1 unit. Similar example can also be found on DSB and NS. DSB increased its efficiency in 1997 and 2001 while gradually digesting sequential deregulation events one by one. On the other hand, NS's efficiency dived in 2002 when a full package was given. Therefore, sequential deregulation events are noticeably favorable for incumbents to absorb and package type might bring ill effect rather than benefits.

6.1.3.c Financial performance

As in the first scenario, leverage ratio becomes the one and only significant financial variables in both models again. In the models without country fixed effects, we can see that the R-squared discrepancy between regressions including or excluding leverage ratios are substantial. Efficiency indices are negatively related to ROA and tend to be insignificant in regressions excluding leverage ratios as observed in previous models. Two new added deregulation dummies are both insignificant here and we expect country fixed effect will alter this.

After country fixed effects are added to models in this scenario, R-squared rises again, which is in line with our expectation. The significances of efficiency indices drop to a lower level. The absolute values of leverage ratio coefficients remain around 0.2, which indicate an approx.0.2%, drop in ROA every 1% increase in leverage. Package deregulation dummies fail to change their insignificances whereas sequential deregulation dummies show significance whenever leverage ratios are included. However, the sequential deregulation dummies seem to have a negative impact on incumbents' financial performances, which is fairly sensible since the model is considerably close to the previous one in term of events timing (i.e. most of the countries conducting more than two events do it as a package and the ones implementing only one event do it in a sequential way).

6.1.4 Scenario 4: Organizational vs. Institutional Deregulation

6.1.4.a Regression results

Even if we separate deregulation events into sequential and whole package way, there is still another interesting dimension to add to our analysis. By referring to implementation of infrastructure separation, each country has its own legal and operational approach to make executive moves and those approaches differ principally. One is organizational separation by splitting different entities but being still under one legal holding company and the other is institutional separation by setting up two new standalone legal entities. Those different approaches will raise discriminatory manner to incumbents and new entrants in terms of track usage range, access to maintenance depot, signaling and system homologation. Furthermore, albeit on paper third party access is implemented, the convenience of accessing directly impacts on private operators' willingness to compete with incumbents. For instance, third party access in Belgium is way more difficult and time-consuming compared to Sweden. It took the only active Belgian private operators apart from SNCB approximately two years to obtain all the necessary certificates³. In Sweden identification of the responsible contacts for market access and license issue takes only a few hours and the requested information is

³ Now in Belgian law, this process is restricted to three months, but in practice many practical issues like document translation and locomotive driver certificate exam can prolong the whole process to two-three years.

generally provided in writing within a few days or is available immediately on the internet. (Rail Liberalization Index 2007). That's the reason why we want to further drill down the deregulation events and split countries/incumbents into different categories so as to have a new perspective.

Referred to details in Table 3 of Appendices, for countries/incumbents with organizational separation, *Dereg_Org_t* is valued one when organizational separation are implemented and maintained, and zero otherwise. For countries/incumbents with institutional separation, *Dereg_Ins_t* is valued one when institutional separation happened, and zero otherwise. From this model (see Table 4IV & 6IV in Appendices), we can still find a close input-output productivity increase compared to previous models:

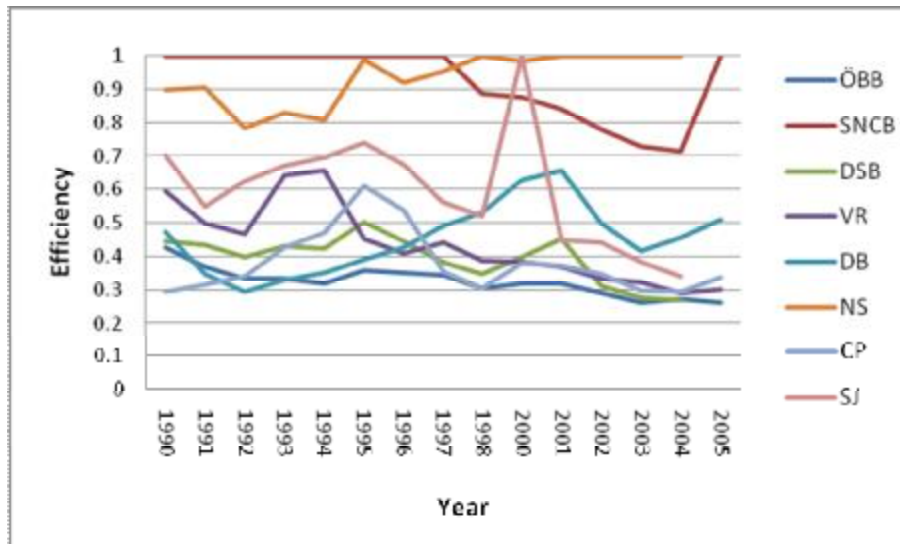
$$\text{Country: } \alpha_{\text{capital}}(0.706) + \alpha_{\text{labor}}(1.171) = 1.877 > 1$$

$$\text{Incumbent: } \alpha_{\text{capital}}(0.648) + \alpha_{\text{labor}}(1.179) = 1.827 > 1$$

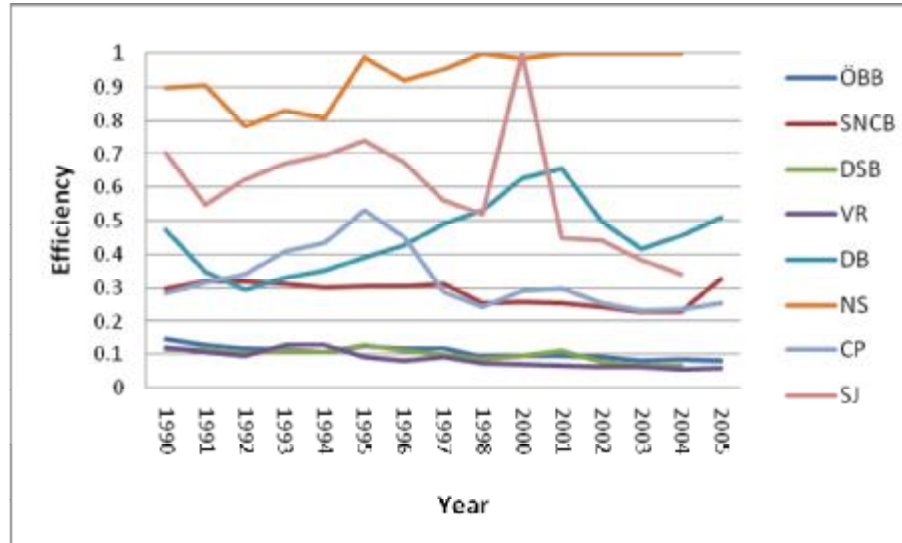
This time we have significant positive coefficients of institutional separation and insignificant negative coefficients of organizational separation for both country and incumbent model. It appears that institutional separation is more favorable for input-output productivity increase since it entitles the incumbent group less control power over who is able to run on the national tracks. (Incumbents operation company more or less still have residual control power on access to tracks even the track company is legally separated). Therefore higher track openness creates positive correlation with input-output productivity increase. This result is in support of former part of our hypothesis 3c, we will further verify if institutional separation is more favorable in terms of financial performances later on.

6.1.4.b Relative efficiency comparison

GRAPH 4A INCUMBENT TOTAL RELATIVE EFFICIENCY TREND (MODEL 4)



GRAPH 4B INCUMBENT FREIGHT RELATIVE EFFICIENCY TREND (MODEL 4)



An interesting pattern can be found here, most incumbents' total and freight efficiency plunged after their separation of infrastructure from operations. However, countries with organizational separations like Germany and the Netherlands could recover from their drop and boost their efficiency gradually in the next few years whereas countries with institutional separations like Denmark, Belgium and Finland kept their negative trend down even after several years. It proves that losing infrastructure can be pernicious to incumbents in term of efficiency but not profitability as we demonstrate in next part.

6.1.4.c Financial performance

As previous models, leverage ratio is still the only significant financial variables across all regressions in this scenario, which further strengthen its explaining power. We also find that models only including *Logarithm (asset)* variable tend to have the lowest R-squared (0.09 in model without country fixed effect and 0.7962 with country fixed effect). Its weakest empirical explaining power however contrasts its denominator position in the dependent variable.

In the model with country fixed effect, apart from significant negative parameters of leverage ratio, what is more worthy noticing is the comparison between a positive effect (significant at 5% level) of institutional deregulation and a negative effect of organizational deregulation. For the positive effect of institutional separation, we argue that the legal split of the gigantic national railway can remove heavy fixed asset (i.e. tracks) from incumbents' balance sheet but with no harm to its profitability since the incumbent operator generally benefit from a "discount" rate on the track running fee from the new infrastructure company

due to its former nepotism. Therefore a lower operating cost can be achieved so as to obtain a higher ROA. Therefore we can not reject our hypothesis 3c.

6.2 HYPOTHESES VALIDATION SUMMARY

Hereafter we present a summary table to show if our models are in favor of our hypotheses.

TABLE 2 HYPOTHESES VS. RESULTS

Hypotheses	Results
Hypothesis 1a: Hypothesis 1a: The liberalization process improves input-output productivity of countries.	Not rejected
Hypothesis 1b: The liberalization process significantly impacts input-output productivity of incumbents.	Not rejected
Hypothesis 2a: Private operators increase their productivity efficiencies faster than incumbents do.	Not rejected
Hypothesis 2b: Private operators are the main driving force of productivity efficiencies improvement on their located countries.	Not rejected
Hypothesis 3a: More than one deregulation events implemented has stronger positive correlation with efficiency and ROA compared to only one deregulation event conducted.	Rejected
Hypothesis 3b: Sequential Deregulation has stronger positive correlation with efficiency and ROA compared to a single deregulation package.	Inconclusive
Hypothesis 3c: Institutional separation of incumbents has stronger positive correlation with efficiency and ROA compared to organizational separation.	Not rejected
Hypothesis 4: Incumbent's efficiency index is correlated with its ROA.	Inconclusive

6.3 ROBUSTNESS TEST

We carry out additions regressions with less control variables however in different combinations and summarized them in Appendices Table 10, Table 13, Table 16 and Table 19 for Scenario 1 to Scenario 4 accordingly. By looking at the coefficients and their associated t-values, we conclude that our results are robust.

Overall, leverage seems to be the key financial variable behind ROA. In order to look at the long-run effects of leverage on ROA using the alternative deregulation scenarios, we tried to run one more set of regressions with leverage and lagged leverage and different deregulation dummies respectively. However, due to the limit dataset, we failed to carry out the regressions.

7. CONCLUSION

The results suggest that the liberalization process generally improves input-output productivity of countries and incumbents, who however outperformed by private operators, indicating countries' input-output productivity is enhanced mostly by new entrants.

Results of relative total/freight efficiency indices illustrate contradistinctive illations in conjunction with incumbents' own country specifics. For example, countries like Germany, the Netherlands and Sweden with large market potentials, adequate legal preparations and progressive attitudes, their relative efficiency rankings firstly damaged by onrush of new entrants and then improved by their resiliencies. For country like Portugal and Belgium, with limited market potential, their relative efficiency rankings tend to unaffected due to their ascendancies local markets for the start and worsened later on.

The results also show the importance of controlling for country specific unobservables, which differ drastically across European countries, suggesting collective deregulation directives might be a far cry from a tailor-made approach.

There is evidence showing that leverage ratio acts as a dominant financial indicator related to companies' return on assets during the liberalization process. The more incumbents are leveraged, the worse financial results they have, which we interpret as a hysteresis effect of the Capex, which is mostly leveraged.

Our results also indicate that no matter how deregulation events are implemented, they deteriorate incumbents' financial performances except for institutional separation of operation and infrastructure, which can be justified by its immediate offload of balance sheet for operation companies.

On a more general level, the results of the paper suggest that liberalization process improved incumbents' efficiencies, but not to an extent that could beat new entrants and subsequently boost their financial performances.

8. FURTHER RESEARCH

The European railway deregulation is an ongoing process. EU is still revising current setups, amending provisions and releasing new directives. Accordingly the adaptation of each country/incumbent is a dynamic process rather than a static outcome. Hence some limitations of our research are addressed here.

Firstly, passenger railway transport will not be entirely opened to private operators by EU legislation in EU countries until 2010. Therefore the total efficiency increase of a certain country we addressed in our articles is more or less mainly driven by impact occurred on freight transport segment. It's also valuable to separately measure efficiency of passenger service since more intangible assets of incumbents such as long-term brand recognition and customer loyalty would be supposedly involved in the model.

Secondly, an indirect reasoning has been adopted to demonstrate the higher relative input-output productivity improvement of private operators. We hope that a robust data set of all private operators would be available in the future so as a direct comparison on efficiencies of incumbents and private operators can be constructed to consolidate our arguments.

Thirdly, we couldn't examine France, Italy and Spain due the financial data limitation even though we tried our best to pursuit the more up-to-date annual reports as from we started our research. Among these countries, France is the second biggest railway market just next to Germany in Europe. Also Paris and Lyon are hubs for several crucial railway freight corridors. However the regulation to new entrants is very tight, which makes itself an interesting case to explore. Italy and Spain is another case worthwhile to scrutinize since the cabotage for foreign new entrants is purely based on reciprocity and the national incumbent contracts all the railway related services.

Last but not the least, we find few evidence to attest immediate financial performance improvements of incumbents triggered by the efficiency increases, however we expect a increased ROA in a long run after all those Capex run into effect. Moreover it's also constructive to this research to compare private operators' financial performance and see their P&Ls pattern since most of their business model are established on short-term (5-10 years) franchise operation running by leased train units and on leased track. And the train maintenances are outsourced to third party service providers.

9. REFERENCES

- Andrew F. Daughety, 1978, Stochastic production and cost production duality, Discussion Papers 356R, Northwestern University.
- Bruno De Borger, 1993, The economic environment and public enterprise behavior: Belgian railroads, 1950-86, *Economic* 60, 443-463.
- C Tofallis, 2001, Combining two approaches to efficiency assessment, *The Journal of the Operational Research Society* 52, 1225-1231.
- Charles K. Ng and Paul Seabright, 2001, Competition, privatization and productive efficiency: Evidence from the airline industry, *The Economic Journal* 111, 591-619.
- Douglas W. Caves, Laurits R. Christensen and Joseph A. Swanson, 1981, Economic performance in regulated and unregulated environments: A comparison of U.S. and Canadian Railroads, *The Quarterly Journal of Economics* 96, 559-581.
- Efraim Benmelech, 2005, Asset salability and debt maturity: Evidence from 19th century American railroads, Working Paper 14, FDIC Center for Financial Research.
- European Communities, 1991, Council Directive 91/440/EEC, Official Journal L 237, Office for Official Publications of the European Communities.
- European Conference of Ministers of Transport, 2006, *Trend in the transport sector: 1970-2004*, France: OECD Publication Services.
- Friebel, Guido, Ivaldi, Marc and Vibes, Catherine, 2004, Railway (De)Regulation: A European efficiency comparison, CEPR Discussion Papers 4319, C.E.P.R. Discussion Papers.
- Guido Friebel, Sergei Guriev, Russell Pittman, Elizaveta Shevyakhova and Anna Tomová, 2007, Railroad Restructuring in Russia and Central and Eastern Europe: One Solution for All Problems?, *Transport Reviews* 27, 251 – 271.
- Heike Wetzel and Christian Growitsch, 2006, Economies of scope in European railways: an efficiency analysis, IWH-Discussion Papers 5, Halle Institute for Economic Research.
- Jith Jayaratne and Philip E. Strahan, 1998, Entry restrictions, industry evolution, and dynamic efficiency: Evidence from commercial banking, *Journal of Law and Economics* 41, 239-273.

- Jun Qian and Philip E. Strahan, 2007, How laws and institutions shape financial contracts: The case of bank loans, *The Journal of Finance* 6, 2803-2834.
- Kalyan Chakraborty, Basudeb Biswas and W. Cris Lewis, 2001, Measurement of technical efficiency in public education: A stochastic and nonstochastic production function approach, *Southern Economic Journal* 67, 889-905.
- Kenneth J. Button and Thomas G. Weyman-Jones, 1992, Ownership structure, institutional organization and measured X-efficiency, *The American Economic Review* 82, 439-445.
- Lawrence R. Klein, 1953, *A Textbook of Econometrics*, Evanston, Illinois and White Plains, N.Y.: Row, Peterson & Co.
- Léopold Simar, 1992, Estimating efficiencies from frontier models with panel data: A comparison of parametric, non-parametric and semi-parametric methods with bootstrapping, *Journal of Productivity Analysis* 3, 171-203.
- Marc Ivaldi and Catherine Vibes, 2005, Intermodal and intramodal competition in passenger rail transport, CEPR Discussion Papers 5004, C.E.P.R. Discussion Papers.
- Oum T. H. and WATERS II W.G., 1996, Recent developments in cost function research in transportation, *Logistics and Transportation Review* 32, 423-463.
- P. Seabright, 2003, The economies of passenger rail transport: A survey, IDEI Report 1 on passenger rail transport, Institut D'Economie Industrielle.
- Preston J.M., Shires J., Garlick M., Hodgson F.C. and Nash C.A., 1994, European railway comparisons: Final report, working paper 418, University of Leeds.
- Rafael Lalivea and Armin Schmutzler, 2008, Exploring the effects of competition for railway markets, *International Journal of Industrial Organization* 26, 443-458.
- Randall S. Brown, Douglas W. Caves and Laurits R. Christensen, 1979, Modelling the structure of cost and production for multiproduct firms, *Southern Economic Journal* 46, 256-273.
- Renée B. Adams, Heitor Almeida and Daniel Ferreira, 2003, Understanding the Relationship between Founder-CEOs and Firm Performance, Finance Working Paper 036, New York University.

Renée B. Adams, Heitor Almeida and Daniel Ferreira, 2005, Powerful CEOs and their Impact on Corporate Performance, *Review of Financial Studies* 18, 1403-1432.

Subal C. Kumbhakar, Almas Heshmati and Lennart Hjalmarsson, 1999, Parametric approaches to productivity measurement: A comparison among alternative models, *The Scandinavian Journal of Economics* 101, 405-424.

Wiegmans Bart W. and Donders A. Rogier T., 2007, Benchmarking European rail freight transport companies, *Transportation Journal* 46, 19-34.

Yair Mundlak, 1963, Specification and estimation of multiproduct production functions, *Journal of Farm Economics* 45, 433-443.

Electronic and Other Sources

Marc Ivaldi and Catherine Vibes, 2004, Entry and product competition in the long-haul passenger market <http://idei.fr/doc/conf/rai/papers_2004/vibes_ivaldi.pdf>

IBM Global Business Services and Christian Kirchner, 2007, Rail Liberalization Index 2007 <<http://www.railcargo.nl/documenten/IBM%20Study%20rail%20liberalisation%20index%202007%20summary.pdf>>

OECD Competition Committee, 2006, Report on experiences with structural separation <<http://www.oecd.org/dataoecd/19/32/39796493.pdf>>

10. APPENDICES**Table 1 Summary Statistics**

Panel A

<i>Incumbent</i>	<i>Period</i>	<i>Route-km</i>	<i>Staff</i>	<i>Freight tonne-km (million)</i>	<i>Passenger-km (million)</i>
<i>Austria/Öbb</i>	1980-2005	5691	61594	13411	7917
<i>Belgium/SNCB</i>	1980-2005	3564	48248	8271	7084
<i>Denmark/DSB</i>	1980-2005	2285	16783	1657	4841
<i>Finland/VR</i>	1980-2005	5896	19156	8693	3242
<i>Germany/DB AG</i>	1980-2005	39770	368657	90186	64696
<i>The Netherlands/NS</i>	1980-2005	2814	25622	3160	12392
<i>Portugal/CP</i>	1980-2005	3146	15867	1868	4958
<i>Sweden/SJ</i>	1980-2005	10563	20858	15491	6178

Panel B

<i>Country</i>	<i>Period</i>	<i>Route-km</i>	<i>Staff</i>	<i>Freight tonne-km (million)</i>	<i>Passenger-km (million)</i>
<i>Austria</i>	1980-2005	5667	60312	13297	8186
<i>Belgium</i>	1980-2005	3565	47223	7930	7119
<i>Denmark</i>	1980-2005	2285	17670	1706	4857
<i>Finland</i>	1980-2005	5896	18819	8822	3242
<i>Germany</i>	1980-2005	39777	381425	90890	66041
<i>The Netherlands</i>	1980-2005	2814	25861	3164	12209
<i>Portugal</i>	1980-2005	3146	16990	1774	4958
<i>Sweden</i>	1980-2005	10563	23486	16693	6153

Panel C

<i>Incumbent</i>	<i>Period</i>	<i>ROA</i>	<i>Long-term debt/Assets</i>	<i>Logarithm (Asset)</i>	<i>Capex/Sales</i>
<i>Austria/Öbb</i>	2002-2005	0.0035	0.2737	23.6396	5.0596
<i>Belgium/SNCB</i>	2002-2005	-0.0220	0.2772	23.5303	0.1212
<i>Denmark/DSB</i>	2002-2005	0.0341	0.3864	21.7706	0.8836
<i>Finland/VR</i>	2002-2005	0.0269	0.0023	21.1193	0.7447
<i>Germany/DB AG</i>	2002-2005	0.0004	0.4060	24.5754	0.8367
<i>The Netherlands/NS</i>	2002-2005	0.0154	0.1427	22.5157	1.0880
<i>Portugal/CP</i>	2002-2005	-0.1518	1.2945	21.1582	-21.3963
<i>Sweden/SJ</i>	2002-2005	0.0073	0.4894	20.6083	0.5729

Note: Panel A reports means per incumbent over the estimation period for efficiency analysis. Panel B reports means per country over the estimation period for efficiency analysis. Panel C reports means per incumbent over the estimation period for financial analysis. ROA = net income/book value of assets. Logarithm(Assets) is the natural log of book value of assets. Leverage = Book value of long-term debt/book value of assets. Capex/Sales = Capital Expenditure/Total Sales.

Table 2 Deregulation Reforms (three main aspects)

	<i>Separation infrastructure, operations</i>		<i>Third party access</i>		<i>Independent regulatory entity</i>	
	<i>Ivaldi et al</i>	<i>Liu&Shi</i>	<i>Ivaldi et al</i>	<i>Liu&Shi</i>	<i>Ivaldi et al</i>	<i>Liu&Shi</i>
<i>Austria</i>	1997	2004	1995	2001	2000	2004
<i>Belgium</i>	1998	2005				
<i>Denmark</i>	1997	1997	2000	2001		1999
<i>Finland</i>	1995	1995	1999			
<i>Germany</i>	1994		1994	1995		
<i>Netherlands</i>	1995	2002	1995	2003		
<i>Portugal</i>	1997	1997			1997	1998
<i>Sweden</i>	1988	1988	1989	1996		2001

Note: This table compares the year when deregulation reforms were implemented (Liu&Shi) to the one when deregulation reforms were introduced (Ivalid et al).

Table 3 Types of Separation of infrastructure from operations

	<i>Organizational</i>	<i>Institutional or Full</i>
<i>Austria</i>	From 2004	
<i>Belgium</i>	From 2005	
<i>Denmark</i>		From 1997
<i>Finland</i>		From 1995
<i>Germany</i>		
<i>Netherlands</i>	From 2002	
<i>Portugal</i>		From 1997
<i>Sweden</i>		From 1988

Note: This table reports different types of separation of infrastructure from operations across countries. Definitions are from Prognos (1998) that organizational separation means countries/incumbents have created separate bodies and separate accounting, but retain them under the umbrella of one holding infrastructure. Institutional separation means countries have two (or more) independent institutions.

Table4 Incumbents OLS Regression Model for Efficiency Analysis

	I		II		III		IV	
<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Logarithm (Capital)</i>	0.628***	8.22	0.627***	8.19	0.623***	8.17	0.648***	9.20
<i>Logarithm (Labor)</i>	1.144***	13.13	1.138***	13.00	1.148***	13.19	1.179***	14.43
<i>Deregulation Productivity Trend</i>	0.015***	4.10						
<i>One Aspect Deregulation Productivity Trend</i>			0.013***	3.26				
<i>Two Aspect Deregulation Productivity Trend</i>			0.016***	3.77				
<i>Sequential Deregulation Productivity Trend</i>					0.016***	4.29		
<i>Package Deregulation Productivity Trend</i>					-0.012	-1.33		
<i>Organizational Deregulation Productivity Trend</i>							-0.006	-1.27
<i>Insitutional Deregulation Productivity Trend</i>							0.032***	6.80
<i>Productivity Trend Austria/ÖBB</i>	0.041***	8.06	0.041***	7.99	0.043***	8.13	0.049***	11.45
<i>Productivity Trend Belgium/SNCB</i>	0.053***	11.18	0.053***	11.09	0.053***	11.16	0.056***	12.52
<i>Productivity Trend Denmark/DSB</i>	0.019***	2.97	0.018***	2.65	0.018***	2.81	0.007	1.00
<i>Productivity Trend Finland/VR</i>	0.033***	4.20	0.033***	4.25	0.031***	4.04	0.013	1.59
<i>Productivity Trend Germany/DB</i>	-0.001	-0.14	0.000	0.03	-0.002	-0.30	0.021***	3.47
<i>Productivity Trend The Nethelends/NS</i>	0.047***	8.81	0.046***	8.52	0.046***	8.71	0.06***	11.52
<i>Productivity Trend Portugal/CP</i>	0.016**	2.24	0.014*	1.94	0.015**	2.08	0.002	0.23
<i>Productivity Trend Sweden/SJ</i>	0.048***	4.41	0.047***	4.28	0.046***	4.25	0.029***	2.64
<i>Intercept</i>	-4.324***	-10.17	-4.28***	-9.94	-4.326***	-10.20	-3.626***	-8.93
<i>λ</i>		0.408		0.406		0.405		0.543
<i>No. of observations</i>		204		204		204		204
<i>R-Squared</i>		0.9687		0.9687		0.9689		0.9757
<i>F-test p-value</i>		0.00		0.00		0.00		0.00

Note: This table reports estimates and t-statistics for alternative regressions with the aggregate output measure as the dependent variable. *λ* provides the best fit of the aggregate model. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively.

Table 5 Robustness Tests of Incumbents OLS Regression Model for Efficiency Analysis

Scenario 1

<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Logarithm (Capital)</i>	0.637***	9.66
<i>Logarithm (Labor)</i>	0.867***	11.28
<i>Deregulation Productivity Trend Austria/ÖBB</i>	0.842***	4.69
<i>Deregulation Productivity Trend Belgium/SNCB</i>	0.742*	1.87
<i>Deregulation Productivity Trend Denmark/DSB</i>	0.341**	2.21
<i>Deregulation Productivity Trend Finland/VR</i>	0.826***	5.40
<i>Deregulation Productivity Trend Germany/DB</i>	0.126	0.82
<i>Deregulation Productivity Trend The Netherlands/NS</i>	0.496**	2.14
<i>Deregulation Productivity Trend Portugal/CP</i>	0.519***	3.24
<i>Deregulation Productivity Trend Sweden/SJ</i>	1.003***	6.04
<i>Intercept</i>	-3.293***	-8.84
<i>λ</i>		0.232
<i>No. of observations</i>		204
<i>R-Squared</i>		0.9222
<i>F-test p-value</i>		0.00

Scenario 2

<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Logarithm (Capital)</i>	0.706***	10.17
<i>Logarithm (Labor)</i>	0.826***	10.36
<i>One Aspect Deregulation Productivity Trend Austria/ÖBB</i>	0.820***	3.55
<i>One Aspect Deregulation Productivity Trend Belgium/SNCB</i>	0.742*	1.87
<i>One Aspect Deregulation Productivity Trend Denmark/DSB</i>	0.255	0.89
<i>One Aspect Deregulation Productivity Trend Finland/VR</i>	0.880***	5.64
<i>One Aspect Deregulation Productivity Trend Germany/DB</i>	0.177	1.15
<i>One Aspect Deregulation Productivity Trend The Nethelends/NS</i>	0.444	1.12
<i>One Aspect Deregulation Productivity Trend Portugal/CP</i>	0.252	0.63
<i>One Aspect Deregulation Productivity Trend Sweden/SJ</i>	0.912***	5.06
<i>Two Apects Deregulation Productivity Trend Austria/ÖBB</i>	0.874***	3.10
<i>Two Apects Deregulation Productivity Trend Belgium/SNCB</i>	(dropped)	0.00
<i>Two Apects Deregulation Productivity Trend Denmark/DSB</i>	0.44**	2.50
<i>Two Apects Deregulation Productivity Trend Finland/VR</i>	(dropped)	0.00
<i>Two Apects Deregulation Productivity Trend Germany/DB</i>	(dropped)	0.00
<i>Two Apects Deregulation Productivity Trend The Nethelends/NS</i>	0.579**	2.05
<i>Two Apects Deregulation Productivity Trend Portugal/CP</i>	0.631***	3.68
<i>Two Apects Deregulation Productivity Trend Sweden/SJ</i>	1.277***	5.98
<i>Intercept</i>	-3.326***	-8.84
λ		0.271
<i>No. of observations</i>		204
<i>R-Squared</i>		0.9266
<i>F-test p-value</i>		0.00

Scenario 3

<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Logarithm (Capital)</i>	0.637***	9.64
<i>Logarithm (Labor)</i>	0.866***	11.25
<i>Package Deregulation Productivity Trend Austria/ÖBB</i>	0.821***	3.56
<i>Package Deregulation Productivity Trend Belgium/SNCB</i>	0.742*	1.87
<i>Package Deregulation Productivity Trend Denmark/DSB</i>	0.341**	2.20
<i>Package Deregulation Productivity Trend Finland/VR</i>	0.826***	5.38
<i>Package Deregulation Productivity Trend Germany/DB</i>	0.126	0.82
<i>Package Deregulation Productivity Trend The Nethelends/NS</i>	0.496**	2.14
<i>Package Deregulation Productivity Trend Portugal/CP</i>	0.519***	3.24
<i>Package Deregulation Productivity Trend Sweden/SJ</i>	1.003***	6.02
<i>Sequential Deregulation Productivity Trend Austria/ÖBB</i>	0.053	0.15
<i>Sequential Deregulation Productivity Trend Belgium/SNCB</i>	(dropped)	0.00
<i>Sequential Deregulation Productivity Trend Denmark/DSB</i>	(dropped)	0.00
<i>Sequential Deregulation Productivity Trend Finland/VR</i>	(dropped)	0.00
<i>Sequential Deregulation Productivity Trend Germany/DB</i>	(dropped)	0.00
<i>Sequential Deregulation Productivity Trend The Nethelends/NS</i>	(dropped)	0.00
<i>Sequential Deregulation Productivity Trend Portugal/CP</i>	(dropped)	0.00
<i>Sequential Deregulation Productivity Trend Sweden/SJ</i>	(dropped)	0.00
<i>Intercept</i>	-3.293***	-8.82
λ		0.232
<i>No. of observations</i>		204
<i>R-Squared</i>		0.9222
<i>F-test p-value</i>		0.00

Scenario 4

Variables	Coefficient	t-value
Logarithm (Capital)	0.620***	9.22
Logarithm (Labor)	0.887***	12.19
Organizational Deregulation Productivity Trend Austria/ÖBB	0.851***	2.94
Organizational Deregulation Productivity Trend Belgium/SNCB	0.724*	1.77
Organizational Deregulation Productivity Trend Denmark/DSB	(dropped)	0.00
Organizational Deregulation Productivity Trend Finland/VR	(dropped)	0.00
Organizational Deregulation Productivity Trend Germany/DB	(dropped)	0.00
Organizational Deregulation Productivity Trend The Netherlands/NS	0.469*	1.96
Organizational Deregulation Productivity Trend Portugal/CP	(dropped)	0.00
Organizational Deregulation Productivity Trend Sweden/SJ	(dropped)	0.00
Institutional Deregulation Productivity Trend Austria/ÖBB	(dropped)	0.00
Institutional Deregulation Productivity Trend Belgium/SNCB	(dropped)	0.00
Institutional Deregulation Productivity Trend Denmark/DSB	0.317**	2.00
Institutional Deregulation Productivity Trend Finland/VR	0.795***	5.10
Institutional Deregulation Productivity Trend Germany/DB	(dropped)	0.00
Institutional Deregulation Productivity Trend The Netherlands/NS	(dropped)	0.00
Institutional Deregulation Productivity Trend Portugal/CP	0.490***	2.98
Institutional Deregulation Productivity Trend Sweden/SJ	0.951***	5.73
Intercept	-3.407***	-9.68
λ		0.216
No. of observations		204
R-Squared		0.9156
F-test p-value		0.00

Note: These tables report estimates and t-statistics for alternative regressions with the aggregate output measure as the dependent variable. λ provides the best fit of the aggregate model. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively.

Table 6 Countries OLS Regression Model for Efficiency Analysis

	I		II		III		IV	
Variables	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
<i>Logarithm (Capital)</i>	0.764***	11.53	0.757***	11.37	0.76***	11.45	0.706***	10.92
<i>Logarithm (Labor)</i>	1.108***	14.47	1.106***	14.43	1.111***	14.50	1.171***	15.65
<i>Deregulation Productivity Trend</i>	0.014***	4.19						
<i>One Aspect Deregulation Productivity Trend</i>			0.012***	3.33				
<i>Two Aspects Deregulation Productivity Trend</i>			0.015***	3.84				
<i>Sequential Deregulation Productivity Trend</i>					0.014***	4.32		
<i>Package Deregulation Productivity Trend</i>					-0.009	-1.06		
<i>Organizational Deregulation Productivity Trend</i>							-0.004	-0.92
<i>Insitutional Deregulation Productivity Trend</i>							0.025***	5.48
<i>Productivity Trend Austria</i>	0.04***	8.55	0.04***	8.48	0.041***	8.52	0.048***	11.72
<i>Productivity Trend Belgium</i>	0.048***	11.08	0.048***	11.01	0.048***	11.06	0.051***	12.13
<i>Productivity Trend Denmark</i>	0.016***	2.73	0.014**	2.38	0.015***	2.60	0.006***	0.93
<i>Productivity Trend Finland</i>	0.033***	4.85	0.034***	4.90	0.033***	4.69	0.018**	2.23
<i>Productivity Trend Germany</i>	0.006	0.82	0.007	0.93	0.005	0.70	0.023	4.05
<i>Productivity Trend The Nethelends</i>	0.054***	11.05	0.053***	10.66	0.054***	10.96	0.062***	12.53
<i>Productivity Trend Portugal</i>	0.006	0.98	0.004	0.66	0.005	0.84	-0.006	-0.89
<i>Productivity Trend Sweden</i>	0.04***	4.87	0.038***	4.57	0.039***	4.69	0.023**	2.44
<i>Intercept</i>	-4.12***	-10.70	-4.077***	-10.40	-4.117***	-10.69	-3.524***	-9.13
λ		0.555		0.549		0.553		0.612
<i>No. of observations</i>		206		206		206		206
<i>R-Squared</i>		0.9773		0.9772		0.9774		0.9798
<i>F-test p-value</i>		0.00		0.00		0.00		0.00

Note: This table reports estimates and t-statistics for alternative regressions with the aggregate output measure as the dependent variable. λ provides the best fit of the aggregate model. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively.

Table 7 Robustness Tests of Countries OLS Regression Model for Efficiency Analysis

Scenario 1

<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Logarithm (Capital)</i>	0.671 ***	10.28
<i>Logarithm (Labor)</i>	0.872 ***	11.66
<i>Deregulation Productivity Trend Austria</i>	0.863 ***	5.00
<i>Deregulation Productivity Trend Belgium</i>	0.621	1.63
<i>Deregulation Productivity Trend Denmark</i>	0.159	1.10
<i>Deregulation Productivity Trend Finland</i>	0.817 ***	5.52
<i>Deregulation Productivity Trend Germany</i>	0.120	0.84
<i>Deregulation Productivity Trend The Nethelends</i>	0.620 ***	2.78
<i>Deregulation Productivity Trend Portugal</i>	0.193	1.35
<i>Deregulation Productivity Trend Sweden</i>	0.785 ***	5.60
<i>Intercept</i>	-3.312 ***	-9.15
λ		0.274
<i>No. of observations</i>		206
<i>R-Squared</i>		0.9320
<i>F-test p-value</i>		0.00

Scenario 2

<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Logarithm (Capital)</i>	0.728***	10.84
<i>Logarithm (Labor)</i>	0.841***	11.02
<i>One Aspect Deregulation Productivity Trend Austria</i>	0.851***	3.84
<i>One Aspect Deregulation Productivity Trend Belgium</i>	0.621	1.63
<i>One Aspect Deregulation Productivity Trend Denmark</i>	-0.098	-0.36
<i>One Aspect Deregulation Productivity Trend Finland</i>	0.859***	5.74
<i>One Aspect Deregulation Productivity Trend Germany</i>	0.160	1.13
<i>One Aspect Deregulation Productivity Trend The Nethelends</i>	0.569	1.49
<i>One Aspect Deregulation Productivity Trend Portugal</i>	0.052	0.14
<i>One Aspect Deregulation Productivity Trend Sweden</i>	0.658***	4.07
<i>Two Aspects Deregulation Productivity Trend Austria</i>	0.885***	3.27
<i>Two Aspects Deregulation Productivity Trend Belgium</i>	(dropped)	0.00
<i>Two Aspects Deregulation Productivity Trend Denmark</i>	0.283*	1.72
<i>Two Aspects Deregulation Productivity Trend Finland</i>	(dropped)	0.00
<i>Two Aspects Deregulation Productivity Trend Germany</i>	(dropped)	0.00
<i>Two Aspects Deregulation Productivity Trend The Nethelends</i>	0.707***	2.61
<i>Two Aspects Deregulation Productivity Trend Portugal</i>	0.250	1.65
<i>Two Aspects Deregulation Productivity Trend Sweden</i>	0.992***	5.65
<i>Intercept</i>	-3.338***	-9.17
λ		0.309
<i>No. of observations</i>		206
<i>R-Squared</i>		0.9359
<i>F-test p-value</i>		0.00

Scenario 3

<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Logarithm (Capital)</i>	0.671 ***	10.26
<i>Logarithm (Labor)</i>	0.872 ***	11.63
<i>Package Deregulation Productivity Trend Austria</i>	0.85 ***	3.83
<i>Package Deregulation Productivity Trend Belgium</i>	0.621	1.63
<i>Package Deregulation Productivity Trend Denmark</i>	0.159	1.10
<i>Package Deregulation Productivity Trend Finland</i>	0.817 ***	5.50
<i>Package Deregulation Productivity Trend Germany</i>	0.120	0.84
<i>Package Deregulation Productivity Trend The Nethelends</i>	0.62 ***	2.78
<i>Package Deregulation Productivity Trend Portugal</i>	0.193	1.34
<i>Package Deregulation Productivity Trend Sweden</i>	0.785 ***	5.58
<i>Sequential Deregulation Productivity Trend Austria</i>	0.034	0.10
<i>Sequential Deregulation Productivity Trend Belgium</i>	(dropped)	0.00
<i>Sequential Deregulation Productivity Trend Denmark</i>	(dropped)	0.00
<i>Sequential Deregulation Productivity Trend Finland</i>	(dropped)	0.00
<i>Sequential Deregulation Productivity Trend Germany</i>	(dropped)	0.00
<i>Sequential Deregulation Productivity Trend The Nethelends</i>	(dropped)	0.00
<i>Sequential Deregulation Productivity Trend Portugal</i>	(dropped)	0.00
<i>Sequential Deregulation Productivity Trend Sweden</i>	(dropped)	0.00
<i>Intercept</i>	-3.312 ***	-9.13
λ		0.274
<i>No. of observations</i>		206
<i>R-Squared</i>		0.9320
<i>F-test p-value</i>		0.00

Scenario 4

<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Logarithm (Capital)</i>	0.648***	9.66
<i>Logarithm (Labor)</i>	0.896***	12.49
<i>Organizational Deregulation Productivity Trend Austria</i>	0.861***	3.08
<i>Organizational Deregulation Productivity Trend Belgium</i>	0.603	1.53
<i>Organizational Deregulation Productivity Trend Denmark</i>	(dropped)	0.00
<i>Organizational Deregulation Productivity Trend Finland</i>	(dropped)	0.00
<i>Organizational Deregulation Productivity Trend Germany</i>	(dropped)	0.00
<i>Organizational Deregulation Productivity Trend The Nethelends</i>	0.586**	2.54
<i>Organizational Deregulation Productivity Trend Portugal</i>	(dropped)	0.00
<i>Organizational Deregulation Productivity Trend Sweden</i>	(dropped)	0.00
<i>Institutional Deregulation Productivity Trend Austria</i>	(dropped)	0.00
<i>Institutional Deregulation Productivity Trend Belgium</i>	(dropped)	0.00
<i>Institutional Deregulation Productivity Trend Denmark</i>	0.136	0.91
<i>Institutional Deregulation Productivity Trend Finland</i>	0.781***	5.15
<i>Institutional Deregulation Productivity Trend Germany</i>	(dropped)	0.00
<i>Institutional Deregulation Productivity Trend The Nethelends</i>	(dropped)	0.00
<i>Institutional Deregulation Productivity Trend Portugal</i>	0.167	1.12
<i>Institutional Deregulation Productivity Trend Sweden</i>	0.734***	5.20
<i>Intercept</i>	-3.414***	-10.04
λ		0.255
<i>No. of observations</i>		206
<i>R-Squared</i>		0.9254
<i>F-test p-value</i>		0.00

Note: These tables report estimates and t-statistics for alternative regressions with the aggregate output measure as the dependent variable. λ provides the best fit of the aggregate model. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively.

Table 8 Relative Freight Productivity Efficiency

Scenario 1

	<i>Austria_OeBB</i>	<i>Belgium_SNCB</i>	<i>Denmark_DSB</i>	<i>Finland_VR</i>	<i>Germany_DB</i>	<i>Netherlands_NS</i>	<i>Portugal_CP</i>	<i>Sweden_SJ</i>
1980	0.30	0.34	0.17	0.19	0.54	0.45	0.08	0.28
1981	0.27	0.33	0.18	0.21	0.58	0.45	0.08	0.26
1982	0.32	0.33	0.25	0.23	0.65	0.46	0.10	0.25
1983	0.33	0.35	0.21	0.26	0.70	0.45	0.10	0.29
1984	0.33	0.37	0.20	0.23	0.70	0.45	0.12	0.30
1985	0.32	0.38	0.20	0.22	0.77	0.45	0.12	0.30
1986	0.34	0.37	0.24	0.18	0.87	0.45	0.15	0.32
1987	0.34	0.39	0.24	0.23	0.89	0.46	0.18	0.32
1988	0.34	0.39	0.21	0.23	0.89	0.46	0.18	0.28
1989	0.36	0.39	0.22	0.23	0.88	0.43	0.19	0.30
1990	0.37	0.40	0.23	0.25	0.73	0.44	0.17	0.36
1991	0.35	0.42	0.24	0.22	0.57	0.51	0.20	0.30
1992	0.34	0.42	0.23	0.21	0.51	0.44	0.22	0.34
1993	0.35	0.42	0.25	0.29	0.60	0.46	0.28	0.38
1994	0.35	0.40	0.25	0.29	0.66	0.43	0.30	0.39
1995	0.38	0.36	0.28	0.24	0.55	0.50	0.36	0.38
1996	0.42	0.39	0.27	0.25	0.67	0.48	0.34	0.38
1997	0.44	0.40	0.34	0.29	0.82	0.51	0.33	0.34
1998	0.40	0.34	0.31	0.25	0.92	0.51	0.29	0.31
1999	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
2000	0.29	0.21	0.24	0.16	0.72	0.32	0.23	0.36
2001	0.26	0.24	0.35	0.19	0.93	0.38	0.28	0.19
2002	0.27	0.25	0.28	0.20	0.80	0.26	0.30	0.22
2003	0.28	0.25	0.28	0.22	0.76	0.28	0.29	0.21
2004	0.26	0.24	0.28	0.20	0.83	0.27	0.29	0.18
2005	0.21	0.16	—	0.17	0.79	—	0.29	—

Scenario 2

	<i>Austria_OeBB</i>	<i>Belgium_SNCB</i>	<i>Denmark_DSB</i>	<i>Finland_VR</i>	<i>Germany_DB</i>	<i>Netherlands_NS</i>	<i>Portugal_CP</i>	<i>Sweden_SJ</i>
1980	0.29	0.34	0.17	0.19	0.53	1.00	0.19	0.70
1981	0.25	0.33	0.17	0.20	0.54	1.00	0.19	0.66
1982	0.28	0.34	0.23	0.22	0.57	1.00	0.22	0.65
1983	0.28	0.36	0.19	0.24	0.58	1.00	0.22	0.74
1984	0.26	0.39	0.17	0.21	0.56	1.00	0.25	0.76
1985	0.24	0.39	0.17	0.20	0.57	0.98	0.24	0.76
1986	0.24	0.39	0.20	0.17	0.62	0.99	0.31	0.83
1987	0.23	0.40	0.18	0.20	0.59	0.96	0.34	0.82
1988	0.21	0.39	0.16	0.20	0.56	0.95	0.33	0.70
1989	0.21	0.39	0.15	0.19	0.52	0.86	0.35	0.77
1990	0.21	0.40	0.16	0.20	0.41	0.82	0.29	0.90
1991	0.19	0.42	0.16	0.17	0.30	0.80	0.32	0.73
1992	0.17	0.42	0.15	0.16	0.25	0.69	0.34	0.84
1993	0.17	0.42	0.16	0.22	0.28	0.73	0.41	0.91
1994	0.16	0.41	0.15	0.22	0.30	0.71	0.44	0.96
1995	0.18	0.40	0.18	0.20	0.26	0.84	0.54	1.00
1996	0.18	0.41	0.16	0.19	0.29	0.82	0.48	0.91
1997	0.18	0.42	0.20	0.21	0.33	0.85	0.43	0.76
1998	0.17	0.39	0.19	0.20	0.38	1.00	0.40	0.80
1999	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
2000	0.11	0.25	0.13	0.13	0.28	0.62	0.32	1.00
2001	0.13	0.38	0.24	0.20	0.45	1.00	0.52	0.74
2002	0.14	0.42	0.21	0.21	0.40	0.74	0.53	0.84
2003	0.14	0.42	0.20	0.23	0.36	0.73	0.53	0.82
2004	0.11	0.43	0.20	0.21	0.39	0.73	0.56	0.76
2005	0.13	0.43	—	0.27	0.51	—	0.74	—

Scenario 3

	<i>Austria_OeBB</i>	<i>Belgium_SNCB</i>	<i>Denmark_DSB</i>	<i>Finland_VR</i>	<i>Germany_DB</i>	<i>Netherlands_NS</i>	<i>Portugal_CP</i>	<i>Sweden_SJ</i>
1980	0.28	0.35	0.17	0.19	0.52	1.00	0.19	0.69
1981	0.25	0.34	0.17	0.20	0.53	1.00	0.19	0.65
1982	0.28	0.34	0.23	0.22	0.56	1.00	0.22	0.64
1983	0.27	0.37	0.19	0.24	0.57	1.00	0.22	0.73
1984	0.26	0.39	0.17	0.21	0.55	1.00	0.25	0.75
1985	0.24	0.40	0.17	0.20	0.57	0.98	0.24	0.75
1986	0.24	0.39	0.20	0.17	0.61	0.99	0.31	0.82
1987	0.23	0.40	0.18	0.20	0.58	0.96	0.34	0.81
1988	0.21	0.39	0.16	0.20	0.55	0.95	0.33	0.68
1989	0.21	0.39	0.16	0.19	0.51	0.86	0.35	0.74
1990	0.20	0.41	0.16	0.20	0.40	0.82	0.29	0.86
1991	0.18	0.43	0.16	0.17	0.30	0.79	0.32	0.70
1992	0.17	0.42	0.15	0.16	0.25	0.69	0.34	0.80
1993	0.16	0.42	0.16	0.22	0.28	0.73	0.41	0.87
1994	0.15	0.41	0.15	0.22	0.30	0.71	0.44	0.91
1995	0.18	0.41	0.18	0.20	0.25	0.86	0.56	0.98
1996	0.17	0.41	0.16	0.18	0.27	0.82	0.48	0.91
1997	0.17	0.42	0.19	0.20	0.31	0.85	0.41	0.76
1998	0.16	0.39	0.18	0.19	0.36	1.00	0.40	0.80
1999	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
2000	0.11	0.25	0.14	0.12	0.26	0.63	0.32	1.00
2001	0.12	0.38	0.25	0.18	0.42	1.00	0.52	0.74
2002	0.13	0.42	0.21	0.20	0.37	0.70	0.54	0.84
2003	0.12	0.42	0.20	0.21	0.33	0.74	0.54	0.82
2004	0.15	0.43	0.20	0.20	0.36	0.74	0.56	0.76
2005	0.18	0.43	—	0.27	0.51	—	0.80	—

Scenario 4

	<i>Austria_OeBB</i>	<i>Belgium_SNCB</i>	<i>Denmark_DSB</i>	<i>Finland_VR</i>	<i>Germany_DB</i>	<i>Netherlands_NS</i>	<i>Portugal_CP</i>	<i>Sweden_SJ</i>
1980	0.20	0.24	0.10	0.11	0.58	1.00	0.17	0.63
1981	0.17	0.23	0.11	0.11	0.59	1.00	0.17	0.60
1982	0.18	0.23	0.15	0.13	0.62	1.00	0.20	0.58
1983	0.18	0.25	0.12	0.14	0.64	1.00	0.20	0.66
1984	0.17	0.26	0.11	0.12	0.61	1.00	0.23	0.68
1985	0.16	0.27	0.11	0.11	0.65	1.00	0.22	0.70
1986	0.16	0.26	0.13	0.09	0.69	1.00	0.29	0.75
1987	0.15	0.28	0.12	0.11	0.67	1.00	0.33	0.75
1988	0.15	0.28	0.11	0.12	0.64	1.00	0.32	0.55
1989	0.15	0.28	0.11	0.11	0.61	0.93	0.35	0.61
1990	0.15	0.30	0.11	0.12	0.47	0.90	0.28	0.70
1991	0.13	0.32	0.11	0.11	0.35	0.91	0.32	0.55
1992	0.12	0.32	0.10	0.10	0.29	0.78	0.34	0.63
1993	0.11	0.31	0.11	0.13	0.33	0.83	0.41	0.67
1994	0.11	0.30	0.11	0.13	0.35	0.81	0.43	0.70
1995	0.12	0.30	0.13	0.09	0.39	0.99	0.53	0.74
1996	0.12	0.30	0.11	0.08	0.43	0.92	0.45	0.67
1997	0.12	0.31	0.10	0.09	0.49	0.95	0.29	0.56
1998	0.09	0.25	0.08	0.07	0.53	1.00	0.24	0.52
1999	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
2000	0.10	0.26	0.10	0.07	0.63	0.99	0.29	1.00
2001	0.10	0.25	0.11	0.07	0.66	1.00	0.30	0.45
2002	0.09	0.24	0.08	0.06	0.50	1.00	0.25	0.44
2003	0.08	0.23	0.07	0.06	0.42	1.00	0.23	0.38
2004	0.09	0.23	0.07	0.06	0.46	1.00	0.24	0.34
2005	0.08	0.33	—	0.06	0.51	—	0.26	—

Table 9 OLS Regression Model for Financial Performance Analysis (Scenario 1)

	I		II	
<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Efficiency Index</i>	0.095**	2.09	0.091	0.97
<i>Deregulation Productivity Trend</i>	0.005	1.19	-0.010	-1.02
<i>Long-term debt/Assets</i>	-0.154***	-7.66	-0.198***	-5.04
<i>Logarithm (Asset)</i>	0.002	0.4	0.010	1.17
<i>Capex/Sales</i>	-0.002	-0.55	0.001	0.18
<i>Productivity Trend Austria/ÖBB</i>			0.015	1.22
<i>Productivity Trend Belgium/SNCB</i>			0.007	0.68
<i>Productivity Trend Denmark/DSB</i>			0.039**	2.76
<i>Productivity Trend Finland/VR</i>			0.013	1.18
<i>Productivity Trend Germany/DB</i>			0.016	1.04
<i>Productivity Trend The Nethelends/NS</i>			0.017	1.27
<i>Productivity Trend Portugal/CP</i>			0.033	1.68
<i>Productivity Trend Sweden/SJ</i>			0.043**	2.98
<i>Intercept</i>	-0.061	-0.66	-0.250	-1.22
<i>No. of observations</i>	28		28	
<i>R-Squared</i>	0.8221		0.9261	
<i>F-test p-value</i>	0		0.00	

Note: This table reports estimates and t-statistics for alternative regressions with ROA as the dependent variable. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively. There are one missing value from Capex/Sales Portugal and three from efficiency marked with “—” in Scenario 1, Table 8. The joint insignificance null hypothesis Country fixed-effects are not reported, please see Table 11.

Table 10 Robustness Tests of OLS Regression Model for Financial Performance Analysis (Scenario 1)

Panel A

	I		II		III		IV		V		VI	
<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Efficiency Index</i>	0.0530	0.69	-0.102	-0.89	-0.002	-0.01	0.0660	0.89	0.0790	0.84	0.0170	0.11
<i>Deregulation Productivity Trend</i>	-0.0140	-1.65	-0.004	-0.28	-0.004	-0.25	-0.0100	-1.26	-0.0120	-1.37	0.0000	0.03
<i>Long-term debt/Assets</i>	-0.212***	-5.73					-0.205***	-5.69	-0.203***	-5.12		
<i>Logarithm (Asset)</i>			0.017	1.36			0.0110	1.52			0.0140	1.05
<i>Capex/Sales</i>					0.000	-0.02			0.0020	0.49	-0.0020	-0.28
<i>Productivity Trend Austria/ÖBB</i>	0.023**	2.12	0.004	0.23	0.013	0.70	0.0150	1.36	0.0190	1.66	0.0070	0.34
<i>Productivity Trend Belgium/SNCB</i>	0.0100	1.09	-0.006	-0.42	0.004	0.28	0.0050	0.54	0.0120	1.25	-0.0030	-0.16
<i>Productivity Trend Denmark/DSB</i>	0.043***	3.54	0.041*	2.10	0.029	1.27	0.042***	3.64	0.040**	2.79	0.0280	1.24
<i>Productivity Trend Finland/VR</i>	0.0110	1.07	0.031*	1.80	0.022	1.23	0.0140	1.36	0.0120	1.02	0.0240	1.35
<i>Productivity Trend Germany/DB</i>	0.029**	2.72	0.007	0.32	0.014	0.68	0.0170	1.32	0.027*	2.09	-0.0010	-0.05
<i>Productivity Trend The Netherlands/NS</i>	0.0170	1.34	0.013	0.62	0.018	0.87	0.0150	1.24	0.0180	1.41	0.0150	0.73
<i>Productivity Trend Portugal/CP</i>	0.042**	2.55	-0.019	-0.90	-0.036	-1.52	0.04**	2.51	0.0330	1.66	-0.0330	-1.42
<i>Productivity Trend Sweden/SJ</i>	0.038**	2.83	0.021	0.94	0.010	0.49	0.045***	3.27	0.038**	2.72	0.0180	0.83
<i>Intercept</i>	0.0020	0.04	-0.347	-1.11	-0.025	-0.23	-0.2670	-1.44	-0.0220	-0.33	-0.3530	-1.07
<i>No. of observations</i>		29		29		28		29		28		28
<i>R-Squared</i>		0.9247		0.8007		0.7769		0.9341		0.9189		0.7922
<i>F-test p-value</i>		0.00		0.00		0.00		0.00		0.00		0.00

Panel B

	I		II		III		IV		V		VI	
<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Efficiency Index</i>	0.074	1.63	-0.19***	-3.13	-0.134*	-2.02	0.074	1.61	0.095**	2.13	-0.121*	-1.81
<i>Deregulation Productivity Trend</i>	0.006	1.47	0.003	0.37	0.003	0.38	0.006	1.46	0.005	1.18	0.004	0.5
<i>Long-term debt/Assets</i>	-0.161***	-8.45					-0.159***	-8.08	-0.156***	-8.12		
<i>Logarithm (Asset)</i>			0.008	1.08			0.002	0.51			0.008	1.19
<i>Capex/Sales</i>					-0.009	-1.62			-0.002	-0.49	-0.01*	-1.77
<i>Intercept</i>	-0.016	-0.56	-0.07	-0.39	0.087*	1.88	-0.062	-0.66	-0.025	-0.92	-0.112	-0.65
<i>No. of observations</i>		29		29		28		29		28		28
<i>R-Squared</i>		0.8197		0.3362		0.3073		0.8217		0.8208		0.3473
<i>F-test p-value</i>		0.00		0.02		0.03		0.00		0.00		0.04

Note: These tables report estimates and t-statistics for alternative regressions with ROA as the dependent variable to test robustness of Table 9. Panel A reports results with country fixed-effects while Panel B reports results without country fixed-effects. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively. There are one missing value from Capex/Sales Portugal and three from efficiency marked with “-” in Scenario 1, Table 8. The joint insignificance null hypothesis Country fixed-effects are not reported, please see Table 11.

Table 11 Test for Joint Insignificance Null Hypothesis Country Fixed-Effects (Scenario 1)

<i>Model</i>	<i>d.f. of regression</i>	<i>F-statistic</i>
<i>Table 9</i>	14	2.4632*
<i>Table 10-I</i>	17	4.9544***
<i>Table 10-II</i>	17	2.9616**
<i>Table 10-III</i>	16	4.21***
<i>Table 10-IV</i>	16	3.4157**
<i>Table 10-V</i>	15	2.2648*
<i>Table 10-VI</i>	15	4.0135***

Note: The first column reports the model considered. We perform an F-test that country fixed-effects are (jointly) not significant and report the significance of the statistic. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively.

Table 12 OLS Regression Model for Financial Performance Analysis (Scenario 2)

	I		II	
<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Efficiency Index</i>	-0.078**	-2.57	-0.111*	-2.16
<i>One Aspect Deregulation Productivity Trend</i>	0.002	0.35	-0.022**	-2.48
<i>Two Aspects Deregulation Productivity Trend</i>	0.005	0.93	-0.041**	-2.61
<i>Long-term debt/Assets</i>	-0.120***	-7.26	-0.194***	-5.59
<i>Logarithm (Asset)</i>	-0.002	-0.52	0.000	0.05
<i>Capex/Sales</i>	-0.007*	-1.95	-0.007	-1.22
<i>Productivity Trend Austria/ÖBB</i>			0.042**	2.23
<i>Productivity Trend Belgium/SNCB</i>			0.024*	1.94
<i>Productivity Trend Denmark/DSB</i>			0.069***	3.98
<i>Productivity Trend Finland/VR</i>			0.029**	2.54
<i>Productivity Trend Germany/DB</i>			0.032**	2.43
<i>Productivity Trend The Nethelends/NS</i>			0.047**	2.46
<i>Productivity Trend Portugal/CP</i>			0.082**	3.39
<i>Productivity Trend Sweden/SJ</i>			0.069***	3.74
<i>Intercept</i>	0.143	1.24	0.098	0.49
<i>No. of observations</i>	28		28	
<i>R-Squared</i>	0.8444		0.9465	
<i>F-test p-value</i>	0.00		0.00	

Note: This table reports estimates and t-statistics for alternative regressions with ROA as the dependent variable. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively. There are one missing value from Capex/Sales Portugal and three from efficiency marked with “–” in Scenario 2, Table 8. The joint insignificance null hypothesis Country fixed-effects are not reported, please see Table 14.

Table 13 Robustness Tests of OLS Regression Model for Financial Performance Analysis (Scenario 2)

Panel A

	I		II		III		IV		V		VI	
<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Efficiency Index</i>	-0.083**	-2.20	-0.012	-0.14	-0.099	-1.22	-0.078*	-1.82	-0.112**	-2.50	-0.081	-0.89
<i>One Aspect Deregulation Productivity Trend</i>	-0.022**	-2.85	-0.004	-0.25	-0.011	-0.79	-0.021**	-2.40	-0.022**	-2.84	-0.008	-0.53
<i>Two Aspects Deregulation Productivity Trend</i>	-0.033**	-2.80	-0.020	-0.79	-0.039	-1.55	-0.032**	-2.39	-0.041**	-2.94	-0.034	-1.23
<i>Long-term debt/Assets</i>	-0.205***	-7.10					-0.203***	-6.59	-0.194***	-5.86		
<i>Logarithm (Asset)</i>			0.015	1.06			0.002	0.25			0.007	0.46
<i>Capex/Sales</i>					-0.012	-1.27			-0.007	-1.28	-0.011	-1.16
<i>Productivity Trend Austria/ÖBB</i>	0.031**	2.32	0.025	0.87	0.050	1.67	0.029*	1.93	0.042**	2.53	0.044	1.31
<i>Productivity Trend Belgium/SNCB</i>	0.023**	2.56	0.007	0.30	0.019	1.13	0.021	1.78	0.024**	2.59	0.013	0.60
<i>Productivity Trend Denmark/DSB</i>	0.064***	4.27	0.058*	1.90	0.064*	2.15	0.063***	4.01	0.070***	4.21	0.061*	1.98
<i>Productivity Trend Finland/VR</i>	0.026**	2.52	0.036	1.77	0.037*	1.91	0.026**	2.41	0.029**	2.66	0.036*	1.80
<i>Productivity Trend Germany/DB</i>	0.035***	3.83	0.009	0.36	0.016	0.94	0.033**	2.56	0.032**	3.30	0.009	0.43
<i>Productivity Trend The Netherlands/NS</i>	0.038**	2.55	0.041	1.32	0.059*	1.95	0.036**	2.21	0.047**	2.75	0.054	1.59
<i>Productivity Trend Portugal/CP</i>	0.070***	3.99	-0.009	-0.31	0.019	0.53	0.068***	3.60	0.082***	3.64	0.015	0.41
<i>Productivity Trend Sweden/SJ</i>	0.062***	3.99	0.048	1.58	0.053	1.68	0.061***	3.84	0.069***	3.89	0.052	1.62
<i>Intercept</i>	0.084**	2.89	-0.381	-1.10	0.042	0.69	0.037	0.19	0.108**	3.04	-0.117	-0.33
<i>No. of observations</i>		29		29		28		29		28		28
<i>R-Squared</i>		0.9488		0.8016		0.8155		0.9490		0.9465		0.8182
<i>F-test p-value</i>		0.00		0.00		0.00		0.00		0.00		0.00

Panel B

	I		II		III		IV		V		VI	
<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Efficiency Index</i>	-0.039	-1.69	-0.045	-0.76	-0.136**	-3	-0.040	-1.45	-0.071**	-2.68	-0.145**	-2.72
<i>One Aspect Deregulation Productivity Trend</i>	0.003	0.56	0.009	0.85	0.004	0.48	0.003	0.55	0.002	0.35	0.004	0.48
<i>Two Aspects Deregulation Productivity Trend</i>	0.006	1.24	-0.007	-0.67	-0.003	-0.39	0.006	1.14	0.006	1.2	-0.004	-0.48
<i>Long-term debt/Assets</i>	-0.143***	-9.57					-0.143***	-9.34	-0.121***	-7.4		
<i>Logarithm (Asset)</i>			0.003	0.34			0.000	-0.06			-0.003	-0.34
<i>Capex/Sales</i>					-0.0120***	-3.39			-0.007*	-1.95	-0.020***	-3.34
<i>Intercept</i>	0.057**	2.8	-0.066	-0.26	0.110**	2.7	0.064	0.53	0.084***	3.72	0.181	0.86
<i>No. of observations</i>		29		29		28		29		28		28
<i>R-Squared</i>		0.8265		0.1681		0.4507		0.8265		0.8424		0.4536
<i>F-test p-value</i>		0.33		0.00		0.01		0.00		0.01		0.00

Note: These tables report estimates and t-statistics for alternative regressions with ROA as the dependent variable to test robustness of Table 12. Panel A reports results with country fixed-effects while Panel B reports results without country fixed-effects. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively. There are one missing value from Capex/Sales Portugal and three from efficiency marked with “–” in Scenario 2, Table 8. The joint insignificance null hypothesis Country fixed-effects are not reported, please see Table 14.

Table 14 **Test for Joint Insignificance Null Hypothesis Country Fixed-Effects (Scenario 2)**

<i>Model</i>	<i>d.f. of regression</i>	<i>F-statistic</i>
<i>Table 12</i>	13	3.1036**
<i>Table 13-I</i>	16	6.3843***
<i>Table 13-II</i>	16	4.7765***
<i>Table 13-III</i>	15	3.7064**
<i>Table 13-IV</i>	15	4.5031***
<i>Table 13-V</i>	14	3.4071**
<i>Table 13-VI</i>	14	3.5098**

Note: The first column reports the model considered. We perform an F-test that country fixed-effects are (jointly) not significant and report the significance of the statistic. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively.

Table 15 OLS Regression Model for Financial Performance Analysis (Scenario 3)

	I		II	
<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Efficiency Index</i>	-0.074**	-2.54	-0.084	-1.74
<i>Sequential Deregulation Productivity Trend</i>	0.004	1.01	-0.020*	-2.19
<i>Package Deregulation Productivity Trend</i>	-0.004	-0.52	-0.016	-1.22
<i>Long-term debt/Assets</i>	-0.119***	-7.00	-0.195***	-5.43
<i>Logarithm (Asset)</i>	-0.002	-0.56	0.002	0.26
<i>Capex/Sales</i>	-0.005	-1.34	-0.006	-1.04
<i>Productivity Trend Austria/ÖBB</i>			0.041*	2.02
<i>Productivity Trend Belgium/SNCB</i>			0.019	1.53
<i>Productivity Trend Denmark/DSB</i>			0.050***	4.21
<i>Productivity Trend Finland/VR</i>			0.025*	2.16
<i>Productivity Trend Germany/DB</i>			0.030*	2.20
<i>Productivity Trend The Nethelends/NS</i>			0.026*	1.95
<i>Productivity Trend Portugal/CP</i>			0.061**	3.09
<i>Productivity Trend Sweden/SJ</i>			0.047***	3.43
<i>Intercept</i>	0.136	1.25	0.040	0.20
<i>No. of observations</i>	28		28	
<i>R-Squared</i>	0.8395		0.9418	
<i>F-test p-value</i>	0.00		0.00	

Note: This table reports estimates and t-statistics for alternative regressions with ROA as the dependent variable. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively. There are one missing value from Capex/Sales Portugal and three from efficiency marked with “–” in Scenario 3, Table 8. The joint insignificance null hypothesis Country fixed-effects are not reported, please see Table 17.

Table 16 Robustness Tests of OLS Regression Model for Financial Performance Analysis (Scenario 3)

Panel A

	I		II		III		IV		V		VI	
<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Efficiency Index</i>	-0.067*	-1.80	-0.016	-0.21	-0.081	-1.05	-0.060	-1.46	-0.089*	-2.04	-0.063	-0.75
<i>Sequential Deregulation Productivity Trend</i>	-0.021**	-2.64	-0.004	-0.22	-0.009	-0.66	-0.019*	-2.18	-0.021**	-2.55	-0.006	-0.40
<i>Package Deregulation Productivity Trend</i>	-0.010	-0.92	-0.010	-0.46	-0.022	-0.97	-0.009	-0.84	-0.017	-1.31	-0.020	-0.85
<i>Long-term debt/Assets</i>	-0.206***	-6.96					-0.202***	-6.45	-0.196***	-5.70		
<i>Logarithm (Asset)</i>			0.016	1.12			0.003	0.42			0.008	0.57
<i>Capex/Sales</i>					-0.011	-1.10			-0.006	-1.11	-0.010	-1.00
<i>Productivity Trend Austria/ÖBB</i>	0.032**	2.28	0.018	0.61	0.045	1.39	0.029*	1.83	0.043**	2.37	0.037	1.05
<i>Productivity Trend Belgium/SNCB</i>	0.020**	2.20	0.005	0.25	0.015	0.90	0.017	1.47	0.020*	2.12	0.008	0.40
<i>Productivity Trend Denmark/DSB</i>	0.052***	4.86	0.040*	1.92	0.034	1.73	0.052***	4.63	0.051***	4.39	0.033	1.66
<i>Productivity Trend Finland/VR</i>	0.024**	2.21	0.035	1.72	0.033	1.69	0.023*	2.13	0.025**	2.24	0.032	1.61
<i>Productivity Trend Germany/DB</i>	0.035***	3.70	0.006	0.26	0.014	0.84	0.031**	2.38	0.032**	3.14	0.006	0.29
<i>Productivity Trend The Netherlands/NS</i>	0.026**	2.22	0.025	1.05	0.030	1.41	0.024*	1.88	0.027**	2.24	0.026	1.11
<i>Productivity Trend Portugal/CP</i>	0.057***	3.66	-0.026	-1.26	-0.012	-0.51	0.056***	3.35	0.062**	3.30	-0.014	-0.56
<i>Productivity Trend Sweden/SJ</i>	0.048***	3.91	0.031	1.33	0.021	0.97	0.048***	3.83	0.047***	3.55	0.023	1.03
<i>Intercept</i>	0.074**	2.70	-0.393	-1.15	0.032	0.56	-0.005	-0.03	0.093**	2.76	-0.164	-0.47
<i>No. of observations</i>		29		29		28		29		28		28
<i>R-Squared</i>		0.9454		0.7962		0.8054		0.9460		0.9415		0.8099
<i>F-test p-value</i>		0.00		0.00		0.00		0.00		0.00		0.00

Panel B

	I		II		III		IV		V		VI	
<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Efficiency Index</i>	-0.050*	-2.11	-0.038	-0.63	-0.131**	-3.02	-0.051*	-1.94	-0.067**	-2.58	-0.134**	-2.69
<i>Sequential Deregulation Productivity Trend</i>	0.006	1.48	0.002	0.20	0.000	0.01	0.006	1.42	0.005	1.15	0.000	-0.01
<i>Package Deregulation Productivity Trend</i>	-0.008	-1.29	-0.002	-0.14	0.012	1.09	-0.008	-1.24	-0.004	-0.66	0.012	1.07
<i>Long-term debt/Assets</i>	-0.138***	-10.64					-0.139***	-10.17	-0.119***	-7.10		
<i>Logarithm (Asset)</i>			0.010	0.99			0.000	-0.11			-0.001	-0.14
<i>Capex/Sales</i>					-0.022***	-4.14			-0.005	-1.29	-0.022***	-3.98
<i>Intercept</i>	0.060**	3.09	-0.213	-0.88	0.108**	2.89	0.072	0.66	0.077***	3.54	0.135	0.69
<i>No. of observations</i>		29		29		28		29		28		28
<i>R-Squared</i>		0.8346		0.0912		0.4642		0.8347		0.8371		0.4647
<i>F-test p-value</i>		0.66		0.00		0.00		0.00		0.00		0.01

Note: These tables report estimates and t-statistics for alternative regressions with ROA as the dependent variable to test robustness of Table 15. Panel A reports results with country fixed-effects while Panel B reports results without country fixed-effects. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively. There are one missing value from Capex/Sales Portugal and three from efficiency marked with “-” in Scenario 3, Table 8. The joint insignificance null hypothesis Country fixed-effects are not reported, please see Table 17.

Table 17 Test for Joint Insignificance Null Hypothesis Country Fixed-Effects (Scenario 3)

<i>Model</i>	<i>d.f. of regression</i>	<i>F-statistic</i>
<i>Table 15</i>	13	2.8544**
<i>Table 16-I</i>	16	6.9187***
<i>Table 16-II</i>	16	4.0589***
<i>Table 16-III</i>	15	3.2882**
<i>Table 16-IV</i>	15	3.8686**
<i>Table 16-V</i>	14	3.119**
<i>Table 16-VI</i>	14	3.177**

Note: The first column reports the model considered. We perform an F-test that country fixed-effects are (jointly) not significant and report the significance of the statistic. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively.

Table 18 OLS Regression Model for Financial Performance Analysis (Scenario 4)

<i>Variables</i>	I		II	
	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Efficiency Index</i>	-0.038	-1.26	-0.060	-1.20
<i>Organizational Deregulation Productivity Trend</i>	-0.002	-0.43	-0.012	-1.54
<i>Insitutional Deregulation Productivity Trend</i>	0.009	1.26	0.028**	3.14
<i>Long-term debt/Assets</i>	-0.137***	-7.87	-0.197***	-5.45
<i>Logarithm (Asset)</i>	0.010	1.74	0.010	1.25
<i>Capex/Sales</i>	-0.002	-0.64	-0.002	-0.52
<i>Productivity Trend Austria/ÖBB</i>			0.011	0.87
<i>Productivity Trend Belgium/SNCB</i>			0.008	0.88
<i>Productivity Trend Denmark/DSB</i>			(dropped)	
<i>Productivity Trend Finland/VR</i>			-0.029***	-3.45
<i>Productivity Trend Germany/DB</i>			0.009	1.03
<i>Productivity Trend The Nethelends/NS</i>			0.025*	1.80
<i>Productivity Trend Portugal/CP</i>			0.004	0.28
<i>Productivity Trend Sweden/SJ</i>			-0.004	-0.37
<i>Intercept</i>	-0.181	-1.26	-0.164	-0.91
<i>No. of observations</i>	28		28	
<i>R-Squared</i>	0.8410		0.9347	
<i>F-test p-value</i>	0.00		0.00	

Note: This table reports estimates and t-statistics for alternative regressions with ROA as the dependent variable. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively. There are one missing value from Capex/Sales Portugal and three from efficiency marked with “—” in Scenario 4, Table 8. The joint insignificance null hypothesis Country fixed-effects are not reported, please see Table 20.

Table 19 Robustness Tests of OLS Regression Model for Financial Performance Analysis (Scenario 4)

Panel A

	I		II		III		IV		V		VI	
<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Efficiency Index</i>	-0.036	-0.83	0.006	0.07	0.000	-0.01	-0.050	-1.14	-0.043	-0.87	-0.024	-0.29
<i>Organizational Deregulation Productivity Trend</i>	-0.015**	-2.34	-0.005	-0.42	-0.009	-0.72	-0.011	-1.64	-0.015*	-2.06	-0.005	-0.36
<i>Institutional Deregulation Productivity Trend</i>	0.029***	3.68	(dropped)		-0.036	-3.18	(dropped)		0.029*	2.11	0.028*	1.82
<i>Long-term debt/Assets</i>	-0.208***	-6.62					-0.202***	-6.47	-0.200***	-5.45		
<i>Logarithm (Asset)</i>			0.017	1.27			0.010	1.31			0.014	0.96
<i>Capex/Sales</i>					-0.002	-0.26			-0.001	-0.26	-0.004	-0.45
<i>Productivity Trend Austria/ÖBB</i>	0.018*	1.91	0.012	0.56	0.020	1.06	0.009	0.83	0.018	1.57	0.011	0.51
<i>Productivity Trend Belgium/SNCB</i>	0.012	1.59	0.003	0.19	0.007	0.54	0.008	0.98	0.012	1.43	0.002	0.14
<i>Productivity Trend Denmark/DSB</i>	(dropped)		0.037**	2.61	0.063	3.93	0.030***	3.87	-0.002	-0.13	(dropped)	
<i>Productivity Trend Finland/VR</i>	-0.033***	-4.38	0.031**	2.88	0.056	4.21	0.000	-0.03	-0.033*	-1.84	-0.004	-0.37
<i>Productivity Trend Germany/DB</i>	0.018***	3.62	0.002	0.16	0.011	1.20	0.010	1.34	0.017**	2.98	0.001	0.04
<i>Productivity Trend The Netherlands/NS</i>	0.024*	1.88	0.024	1.05	0.025	1.06	0.023*	1.84	0.025	1.75	0.025	1.07
<i>Productivity Trend Portugal/CP</i>	0.002	0.18	-0.030**	-2.78	(dropped)		0.032**	2.87	(dropped)		-0.059***	-3.51
<i>Productivity Trend Sweden/SJ</i>	-0.009	-1.15	0.027	1.70	0.044	2.78	0.026**	3.08	-0.011	-0.81	-0.011	-0.71
<i>Intercept</i>	0.053*	1.85	-0.433	-1.46	-0.027	-0.54	-0.162	-0.97	0.057	1.70	-0.315	-1.04
<i>No. of observations</i>		29		29		28		29		28		28
<i>R-Squared</i>		0.9368		0.7937		0.7834		0.9429		0.9274		0.7960
<i>F-test p-value</i>		0.00		0.00		0.00		0.00		0.00		0.00

Panel B

	I		II		III		IV		V		VI	
<i>Variables</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>	<i>Coefficient</i>	<i>t-value</i>
<i>Efficiency Index</i>	-0.031	-1.23	-0.001	-0.02	-0.115**	-2.16	-0.023	-0.96	-0.045	-1.47	-0.111*	-2.04
<i>Organizational Deregulation Productivity Trend</i>	-0.003	-0.70	0.003	0.28	0.011	1.24	-0.003	-0.76	-0.002	-0.44	0.011	1.25
<i>Institutional Deregulation Productivity Trend</i>	0.002	0.42	0.001	0.06	-0.015*	-1.81	0.013*	1.96	0.000	-0.06	-0.009	-0.72
<i>Long-term debt/Assets</i>	-0.148***	-10.18					-0.148***	-11.03	-0.134***	-7.42		
<i>Logarithm (Asset)</i>			0.012	0.87			0.013**	2.25			0.007	0.57
<i>Capex/Sales</i>					-0.020***	-3.31			-0.002	-0.59	-0.020***	-3.29
<i>Intercept</i>	0.057***	3.42	-0.289	-0.88	0.085**	2.32	-0.242*	-1.80	0.066***	3.27	-0.071	-0.26
<i>No. of observations</i>		29		29		28		29		28		28
<i>R-Squared</i>		0.8202		0.0763		0.3633		0.8531		0.8181		0.3726
<i>F-test p-value</i>		0.74		0.00		0.03		0.00		0.00		0.05

Note: These tables report estimates and t-statistics for alternative regressions with ROA as the dependent variable to test robustness of Table 18. Panel A reports results with country fixed-effects while Panel B reports results without country fixed-effects. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively. There are one missing value from Capex/Sales Portugal and three from efficiency marked with “-” in Scenario 4, Table 8. The joint insignificance null hypothesis Country fixed-effects are not reported, please see Table 20.

Table 20 Test for Joint Insignificance Null Hypothesis Country Fixed-Effects (Scenario 4)

<i>Model</i>	<i>d.f. of regression</i>	<i>F-statistic</i>
<i>Table 18</i>	14	2.5077*
<i>Table 19-I</i>	17	7.3889***
<i>Table 19-II</i>	17	3.8982***
<i>Table 19-III</i>	16	3.8791**
<i>Table 19-IV</i>	16	3.1459**
<i>Table 19-V</i>	15	2.8234**
<i>Table 19-VI</i>	15	3.8908**

Note: The first column reports the model considered. We perform an F-test that country fixed-effects are (jointly) not significant and report the significance of the statistic. Significance at 10%, 5% and 1% is denoted by *, **, *** respectively.