The impacts of regulatory structures on the efficiency of European railway systems

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The candidate confirms that the work submitted is his own, except where work which has formed part of jointly-authored publications has been included. The contribution of the candidate and the other authors to this work has been explicitly indicated below. The candidate confirms that appropriate credit has been given within the thesis where reference has been made to the work of others.

The following chapters contain parts that have been included in publications:
Chapter 1: Introduction (aim and objectives);
Chapter 2: Literature review on the impacts of railway reforms and illustration of railway reforms;
Chapter 3: Literature review on ideal rail regulator characteristics;
Chapter 6: Construction of regulation index, econometric variables and model (methodology);
Chapter 7: Econometric results;
Chapter 8: Conclusions (findings, policy implications, limitations, future research).
The publication details relate to attended conferences (by the candidate or the co-authors) and are:

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All the parts indicated above have been written by the candidate. The co-authors have contributed with comments on the structure of the overall work and specific sections, and on wording. The quantitative activities (construction of regulation index, econometric methodology, estimates and analysis) have been designed with the support of the co-authors and performed solely by the candidate.

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Lastly, a few words on the protagonist of this thesis. This work stems from a love for railways which has remained with me since childhood. The memory of endless train journeys from Bologna inching along the Italian network towards the southernmost stations of Italy and possibly Europe is still very much with me. My father once told me that the civility of a country can be seen by looking at its railway system. That is very true: railways allow for everyone’s essential right to mobility, and their function should be vigorously safeguarded and enhanced. Rail journeys open up countries, regions and forgotten places: my wish is that those enchanting routes sprucing up each and every railway network would be able to persist in their endeavour to convey beauty.

“If it starts raining now you will get wet, if tonight is going to be cold your throat will be sore, if you walked back in the dark you will need to pluck up courage, if you carry on wandering you will be more and more tired. Every event is in itself peaceful. Call things so that they will stay with you to the last.”

Gianni Celati, *Verso la foce*

“Despondency breaks off its course.
Anguish breaks off its course.
The vulture breaks off its flight.

The eager light streams out,
even the ghosts take a draught.

And our paintings see daylight,
our red beasts of the ice-age studios.

Everything begins to look around.
We walk in the sun in hundreds.

Each man is a half-open door
leading to a room for everyone.

The endless ground under us.

The water is shining among the trees.

The lake is a window into the earth.”

Tomas Tranströmer, *The Half-Finished Heaven*

Abstract

Amongst the reforms altering the European railway industry in the last two decades, the new provisions on rail (or transport) regulators' renovated powers and independence have been little analysed by the literature. This study aims to quantitatively determine the impact of economic regulation on European railways efficiency and qualitatively identify the role of rail regulators across Europe.

The quantitative analysis considers a sample of European railway systems for the period 2002-2010, and measures economic regulation by employing a purposely developed index rather than dummy variables, as widely utilised by previous literature. The findings differ depending on the way outputs are measured, with regulation producing cost reductions either when combined with vertical separation or when accompanied by competition. However, the combined impact of vertical separation and average levels of regulation only reduces costs when train density is below the sample mean.

The qualitative analysis is based on the design of a questionnaire on rail regulation, collecting first-hand evidence from 20 regulators, infrastructure managers and railway operators across Europe. The questions take into account the findings of a specific literature review on a set of ideal characteristics germane to regulators in railways and comparable industries. Regulators seem to have achieved the necessary requirements in order to effectively operate. Independence is guaranteed on paper and in action, high levels of transparency render regulators accountable, and when intervention is requested, their responses appear prompt. On the other hand, the approval of track access charging schemes, together with the monitoring of the efficiency and quality of the infrastructure managers' performances, only at times fully involves the regulators.

Overall, from both analyses a complex scenario emerges, wherein strong economic regulation produces greater benefits in lightly dense contexts and when accompanied by vertical separation and effective competition.

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Chapter 1
Introduction

1.1 Aims and objectives of the thesis

This thesis aims to investigate the impacts produced by economic regulation on the efficiency levels of European railway systems. This represents a gap in the literature on the impacts of European railway reforms, in which little attention has been dedicated to the identification and measurement of the impacts produced by economic regulation on railway efficiency. Filling this gap implies complementing the related literature strand with new and updated results on the effects of the structure, regulation and competition of railways. Quantitative and qualitative analyses have been performed in order to reach this aim. In particular, the interrelated studies of econometric estimations and responses to a specifically developed questionnaire represent the backbone of this work. The choice of carrying out these activities naturally arises from pursuing the following objectives:

i. Defining what an ideal rail regulator should look like, by tracing the related ideal characteristics in the literature;

ii. Examining the role played by regulators based on the literature review on ideal rail regulator characteristics and on the responses to a new survey involving the actors in the European railway industry (regulators, infrastructure managers and railway undertakings) from whom first-hand evidence is collected;

iii. Constructing a newly developed regulation index able to account for the multi-faceted characteristics of regulatory activities in railways;

iv. Employing this regulation index as a variable for econometric estimations based on a railway total cost model, in order to highlight the quantitative effects of economic regulation on a railway system’s cost efficiency;

v. Clarifying the interdependencies between economic regulation, structure and competition in their impacts on a railway system in terms of overall effects on cost efficiency.

1.2 Context and background

Over the last decades the European railway industry has been reshaped by several reforms which have impacted on preeminent aspects such as the financial and organisational structure of railways and the way operators can compete both nationally and continentally. At the beginning of the 1990s, these reforms were considered much needed as a consequence of a growing sectorial decline, generated by multiple problems. Among the others, the fierce intermodal competition produced by road and air modes, the financial strain on public budgets determined by highly subsidised and inefficient national incumbents, and the necessity to strongly invest in a deteriorating infrastructure all represented impelling incentives that the European Commission in particular exploited in order to gradually, yet deeply, reform the railway industry.

The general aims of these reforms envisaged diverse effects, some of which are yet to be fully realised. Promoting competition and contestability in the industry was intended to allow the presence, or at least the threat, of new and potentially more efficient operators in the railway arena, both for freight and passenger services, and both at national and international levels. To foster this, structural reforms were planned too, for the purpose of streamlining the organisations and pushing towards a separation between the infrastructure managers and railway operators, deemed as necessary to disentangle discriminatory webs and release competitive forces. Economic regulation was also under scrutiny, in particular in relation to the design of continental standards for important aspects such as access, charges, safety and interoperability. These effects, attempting to conform to the European Union (EU) fundamental principle of allowing free movement of persons and goods in the European area, prefigured the end of a system denoted by separated national railways, while favouring the creation of a system based on a shared continental market.

The implementation of these railway reforms has been widely and deeply studied by different authors in terms of their impacts on factors such as demand, efficiency and modal share. A number of literature strands have enjoyed great attention: among these, the effects of interventions linked to liberalisation, privatisation and structural re-organisation have been scrutinised producing, at times, opposing results (van de Velde et al., 2012). This thesis will instead pursue a strand only slightly examined by past literature, namely the effects produced by the reforms involving economic regulation on the efficiency levels attained by European railways. The way

the railway markets are now regulated and the role played by, in most cases, recently established railway regulators represent an area deserving accurate analysis for the following principal reasons. Firstly, economic regulation reforms have been designed in order to intervene in significant areas which may greatly affect railway costs, such as promoting competition and tackling discriminatory practices linked to, for instance, the access to and the charging of railway services. Secondly, structural innovations have determined the necessity to better monitor the operations performed by the infrastructure managers. Indeed, the renovating spirit of this modern railway era seems particularly concerned with a greater focus on a more efficient use of public resources destined to the management of the network. Thirdly, the previous reasons have led to, depending on the various systems, the introduction or the empowerment of regulatory bodies within the railway systems, enabled to investigate and independently decide on railway matters. As a consequence of these factors, there exists the need to verify whether the reforms on economic regulations have produced beneficial effects on railway efficiency, attempting to answers questions such as: How is economic regulation impacting on European railways efficiency? What is the role played by railway regulators in this? How are they dealing with discrimination and competition issues? Are infrastructure managers adequately monitored? Is the role played by these regulators relevant within the overall railway governances? This work will attempt to provide answers to these questions by following the structure delineated in the next paragraph.

1.3 Thesis structure

This thesis consists of 8 chapters. After the introductive Chapter 1, Chapter 2 will review the railway reforms implemented in Europe in the last decades. These will be illustrated in chronological order, starting from the earlier and pioneering interventions in the 1990s, and moving onto the description of more recent and organic interventions, namely the Three Railway Packages, the Recast of the First Railway Package and the proposal for a Fourth Railway Package. A deep review of the literature on the impacts of railway reforms will follow, dedicating a larger space to efficiency-related studies. The high amount of this type of works has produced a vibrant and constructive debate on the real impacts of a number of reforms, especially related to changeovers involving the competition levels and the structural models. Other studies will also be reviewed, in connection with, for instance,

subsidisation, transaction costs and modal share. Final considerations will be drawn, clarifying also why the analysis on the impacts of economic regulation on efficiency is seen as a gap that should be filled. Chapter 3 will firstly provide a brief literature review on how economic regulation is measured in studies regarding non-railway but comparable industries. On the basis of the related findings, the choice of employing a newly developed index measuring economic regulation will be proved to be appropriate, rather than relying on dummy variables as most studies in railways do. This choice will constitute one of the principal novelties connoting the econometric estimations of this work.

Chapter 3 will also present another significant literature review seeking for what constitutes an ideal rail regulator. While Chapter 2 defines why the analysis of the impacts of economic regulation may be enriching, Chapter 3 highlights why the choice of adopting a regulation index may be fitting, and which characteristics best define a railway regulator, thereby enhancing the process of measuring regulation. The literature review on the ideal rail regulator characteristics will not only help towards benefitting from a well-built regulation index for econometric estimations, but also shed some light on which key areas need to be taken into account when the regulatory activities are evaluated. The range is variegated, but indicatively these key areas can be distinguished between formal requirements, such as independence and autonomy, and substantial operations, such as the monitoring of the system efficiency. Selecting these key areas will be fundamental in terms of designing the qualitative exercise of this work, namely the questionnaire on the role played by European railway regulators.

This questionnaire will be methodologically introduced in Chapter 4. Here the survey will be explored in terms of its constituent questions, deemed to be able to deeply investigate how the European rail regulators perform against the ideal regulatory characteristics. Also, the addressees of the questionnaire will be listed, and the rationale behind the formalisation of two versions of the questionnaire explained. Further notes concern the progress of the survey and the response rate obtained.

The responses will be instead analysed in Chapter 5. These will be sub-divided according to key area, also carefully explaining which actors were involved for each enquiry, either regulators or infrastructure managers and railway undertakings. In general, findings seem to conform to legislative expectations more from a formal point of view rather than from a substantial

one, since crucial activities on charging systems and efficiency appear still limited for most of the regulators in the sample.

Moving to the quantitative analysis, Chapter 6 will methodologically describe the econometric model chosen for the estimations. Importantly, a section will be solely focusing on the construction of the regulation index, based on the collection and manipulation of data available from IBM and Kirchner (2002, 2004, 2007 and 2011). Links with the literature review on ideal rail regulator characteristics will be provided, in order to ascertain the extent to which the regulation index is able to embrace the key areas outlined by that review. The remaining variables will also be described together with the model based on a translog total cost function and estimated by using seemingly unrelated regressions.

Chapter 7 will report the econometric results, clustered in two main categories. On the one hand, the outcomes for general statistics and production-related variables will be illustrated, mostly in line with expectations and previous studies' findings. On the other hand, the policy variables will be considered, especially in relation to the interrelated roles played by economic regulation, vertical separation and passenger competition.

Lastly, concluding remarks are included in Chapter 8. Novelties and findings of the thesis will be summarised, along with suggestions on future research. Importantly, policy implications from the qualitative and quantitative analyses will be jointly discussed, for the purpose of highlighting the ways economic regulation impacts on the level of efficiency of a railway system (econometric results) and how this is related to the width of functions allocated to regulators (questionnaire responses). In other words, evidence will be examined to detect whether economic regulation produces beneficial effects on railway efficiency and, if that is the case, whether these effects augment when the role played by regulators is strengthened.

Chapter 2
Literature review on impacts of railway reforms

2.1 Introduction

As illustrated in the initial Chapter, this thesis will primarily concentrate on analysing the impacts of reforms on economic regulation upon the efficiency levels of European railways. By pursuing this aim, this research would be able to complement and enrich a rather wide and prolific literature strand on the impacts of railway reforms. In order to appropriately understand where this research is placed and how it interrelates with other studies on railway reforms, a thorough review of the overall strand appears necessary.

This Chapter aims to present this literature review, illustrating the principal studies therein contained and the reforms upon which the related analyses are based. Section 2.2 will illustrate these railway reforms in a chronological way, dedicating a greater space to the reforms on economic regulation which represent the main object of this thesis. The literature review on the impacts of railway reforms will be included in Section 2.3, subdividing the studies on efficiency (Section 2.3.1) and on further profiles (Section 2.3.2). Section 2.3.3 will discuss the main limitations and results of the literature. Conclusive remarks are included in Section 2.4.

2.2 Background on legislation of railway reforms

Multiple European Directives and two Regulations, Four Railway Packages (the last of which is not yet implemented) and one Recast (regarding the First Railway Package) have shaped the policies defining the modern era for European railways. It is useful to distinguish between the early and more recent legislation. In the 1990s a start was made on structural unbundling and on setting the rules for participation in rail industry. However, it is only post-2000 that Three legislative Railway Packages built on this earlier progress, to liberalise entry into the freight and international passenger sectors and to set clear rules regarding structural unbundling, safety and regulation. On regulation, major changes importantly came about with the Recast of the First Railway Package. These legislative developments are explained in more detail below.

The first relevant piece of legislation was the Council Directive 91/440/EEC which inaugurated the reforms by promoting accounting separation between transport services and infrastructure managers, insisting particularly on the

managerial independence and on the financial restructuring of the former actors. The criteria for opening up markets to competition were then refined by Council Directives 95/18/EC and 95/19/EC which, respectively, indicated procedures for licensing, network allocation and charges for those railway undertakings involved in international combined transport of goods and international groupings. This first legislative impulse was completed with provisions in 1996 on the interoperability of the trans-European high-speed rail system (Council Directive 96/48/EC).

Moving to the most recent legislation, the new decade (post-2000) saw the promulgation of Three Railway Packages expanding the liberalisation processes and detailing their founding conditions, continuing on the paths pursued by the above Directives. The First Railway Package (European Parliament and Council Directives 2001/12/EC, 2001/13/EC and 2001/14/EC, “First Railway Package” hereafter) envisaged organisational and accounting separation at the vertical level (that is, between infrastructure and train operations) and accounting separation at the horizontal one (that is, between passenger and freight operations). It also legislated on the validity of licences within the EU and on the requirement of safety certificates for rolling stock, revised the tasks and activities of the infrastructure managers, and prefigured the establishment of independent regulators. With the Second Railway Package (European Parliament and Council Directives 2004/49/EC, 2004/50/EC and 2004/51/EC, and European Parliament and Council Regulation (EC) No.881/2004, “Second Railway Package” hereafter), the focus shifted mainly to safety and interoperability recommendations (among the others, the creation of the European Railway Agency) and, in terms of market openness, on the possibility for international (from 2006) and all remaining types (from 2007) of freight companies to access the whole European network. Lastly, competition in international passenger services as of 2010 was introduced through the Third Railway Package (European Parliament and Council Directives 2007/58/EC and 2007/59/EC, and European Parliament and Council Regulations (EC) Nos. 1370/2007, 1371/2007 and 1372/2007, “Third Railway Package” hereafter), approving also quality standards for this operational segment.

An important legislative breakthrough was formalised in 2012 with the Recast of the First Railway Package (European Parliament and Council Directive 2012/34/EC, “Recast” hereafter), aimed to address issues in major aspects affecting the European rail market. Firstly, difficulties of new entrants gaining access to the market and the consequent protection of

incumbents' positions led to a low level of competition. Secondly, the monitoring activities exerted by national authorities were argued to be inadequate as, in most cases, deficiencies in autonomy, competences and powers had surfaced. Thirdly, the declining quality of railway infrastructure due to limited funds and investments (public and private) affected several European Union countries. Lastly, the incorporation of regulatory functions within ministerial bodies was considered a problem in terms of lack of necessary independence and inability to pursue non-discriminatory actions and monitoring of the quality and efficiency of infrastructure managers' performances. The latter point is important since governments may wish to restrict funding to railways because of fiscal constraints, and therefore an independent regulator may play a key role in ensuring sufficient funds are provided in order to realise the benefits of the reforms.

This Recast was particularly significant in respect of its introduction of specific measures designed for the regulatory authorities. With regards to their competences, these were planned to be more extensive in order to include aspects concerning the access to and charging for railway services, considered to be fundamental for incentivising market entry and preserving fair competition (Article 56). Importantly, as noted above, the independence of these bodies was reinforced, requiring their autonomy from public entities which may pressurise their decisions, and ensuring that regulators were no longer residing within transport ministries (Article 55). Thus regulators, through this legislation, are now required to be independent of both government bodies and railway undertakings. In addition, the activities of sanctioning, audit, investigation and appeals procedures were strengthened, calling for greater cross-border collaboration too (Article 57).

Furthermore, supplementary actions highlighted the width of powers that these regulatory authorities were accorded. Article 30 opened the possibility for the stipulation and management of contracts between these entities and network managers, illustrating how the regulators can evaluate the adequacy of the amount of funding needed to guarantee the performance of the infrastructure for the period of the contract. Moreover, Article 56 introduced stronger powers for regulators in respect of accounting monitoring (relating to conformity with measures in regulatory and separated accounting). This confers on the regulators the possibility of requiring financial accounts of infrastructure managers and railway undertakings, and data on track access charges and financial performance of infrastructure managers. However, it should be noted that the legislation allows these

activities to be alternatively carried out via a multi-annual contract between the infrastructure manager and the government.

The Recast concludes the review of legislation already approved at European level and ratified (already or soon) by the national parliaments. Moving to the most recent normative projects, a final step towards the full implementation of competition conditions in the European area is made by the Fourth Railway Package (COM, (2013) 25, final). In its “market pillar” provisionally agreed at European level in 2015, this Package introduces the right to access domestic passenger markets (for commercial services from 2020), and strongly favours “competition for the market” (tendering procedures) for public service obligations, which may still be directly awarded but only after justifying this choice to the regulator. Further interventions concern the expansion of powers on the part of the European Railway Agency, in order to shorten the rolling-stock authorisation procedure in terms of costs and length, and the preference for separated organisations for railway governance, even in vertically integrated companies, aiming to avoid discriminatory actions from infrastructure managers.

These legislative interventions reflect a complex framework characterising the regulatory activities in European railway systems. As it will be seen in the next Section 2.3, literature preferences focused on other reforming measures, mainly concerned with structural re-organisations and market liberalisation. Investigating the findings of the principal studies on railway reforms will not only provide a review on the overall research progress, but also help understanding how this work fills an important gap in this field.

2.3 Literature review on impacts of railway reforms

Literature on railway economics has produced many studies attempting to assess the impact of the reforms outlined above, whilst reaching diverse conclusions. However, these studies have concentrated on changes in railway organisation, designed to increase competition thus reducing costs and increasing rail market share. Some studies have also taken into account the presence of an independent regulator. In the limited number of cases where this has been done, regulation was measured in a simple way (through dummy variables), not only missing the consideration of further aspects related to *de jure* and *de facto* independence[1], but also failing to

[1] Hanretty and Koop (2010) produced a relevant study on these aspects.

detect the multiple activities and complex remit of the regulatory bodies. One reason for the relatively simple treatment of regulation in previous studies has been that their focus has been on other aspects of the reforms.

The overall review on the literature on the impacts of railway reforms is subdivided in two parts. The first part (Section 2.3.1) will concern the literature covering the impacts of rail reforms (regulatory and other reforms) on efficiency, while in the second (Section 2.3.2) a review on the literature covering the impacts on further profiles is presented. A discussion of the studies is presented in Section 2.3.3, covering the main methodological limitations (Section 2.3.3.1) and the differences in results (Section 2.3.3.2). The findings and limitations of the studies reviewed are also presented in Appendix A.

2.3.1 Studies on the impacts on efficiency

In the last decades, European railway systems have been undertaking reforms modifying their connotations with a view to achieve some relevant objectives, such as higher efficiency, lower restrictions on market access and increase in rail modal share, as pursued by the Railway Packages. This Section will concentrate on the studies investigating the effects of railway reforms on efficiency, around which the analyses of this thesis are centred.

As significant starting point, the attention can be concentrated on the work published by Mizutani and Uranishi (2013). This study considers 30 European and East Asian railway organisations from 1994 to 2007, but important exclusions are indicated, regarding countries such as United Kingdom and United States. In order to classify the different organisational configurations, the authors define five categories of actors: integrated company, railway undertaking (serving both passenger and freight markets), passenger operator only, freight operator only, and infrastructure manager.

Vertical separation is reached when the management of the network and the management of operational services are allocated to different independent bodies, whereas horizontal separation corresponds to the unbundling between passenger and freight operations. Dummies are employed to reflect the presence of these structural forms.

Importantly, the models are distinguished into single-output and multiple-output specifications. The former presents a measurement aggregating passenger and freight outputs along with a hedonic function of the output

characteristics, while the latter features disaggregated measurements of the two types of service (passenger and freight)[2].

The main outcomes attest how the adoption of vertical and horizontal separation produce different consequences. While vertical separation is adversely influenced by high levels of train density in terms of producing cost-reducing effects, horizontal separation may generate cost-reducing effects regardless of other conditions. This is documented by the sign of the coefficients for horizontal separation which, across all the models, turn out to have strong magnitude and statistical significance. The authors attempt to explain this result by highlighting the importance of diseconomies of scope between passenger and freight activities, together with the decrease in episodes of subsidisation destined to passenger segments, typically benefitting from these contributions.

On the other hand, vertical separation as such plays a cost-reducing role too with strong statistical significance but, as mentioned earlier, when considering the cross-term with train density opposing effects are observed. This is potentially determined by coordination and transaction costs which may be particularly high in those circumstances where greater levels of traffic or congestion, for example, force a more substantial use of resources to conclude agreements between counterparts. In these cases, the specialisation advantages deriving from vertical unbundling appear to be neutralised.

Lastly, interesting suggestions for future research on vertical separation effects are indicated. In particular, the authors underline the relevance of the analysis on the different typologies of vertical separation, along with the detection of its indirect effects ascribable to general competitive conditions.

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[2] In particular, output is measured by:

- Total number of train km aggregating both types of service for the single-output model, together with passenger revenue share, load factor of passenger service, passenger travel length and number of freight cars per train as hedonic output characteristics;
- Revenue passenger km and revenue tonne km for the multiple-output model.

The total cost function in both models also comprises: labour, energy (fuel), material and capital prices. In addition, the models include these environmental variables: network (total route length); technology (percentage of electrified lines); and train density (obtained by dividing the number of train km by the total length of a railway and, in turn, by 365 to allow for daily measurements).

This work was subsequently updated by two studies which determined an important breakthrough in the overall literature strand. The first contribution is the comprehensive report produced by van de Velde et al. (2012), providing quali-quantitative findings building on an enhanced version of the dataset utilised by Mizutani and Uranishi (2013). The analytical novelties introduced by this study emerge firstly in relation to the extension of the temporal interval, now from 1994 to 2010. This new data was obtained thanks to involvement of the members of the Community of European Railway and Infrastructure Companies (CER), which also had the possibility of correcting old data. Secondly, United Kingdom is importantly included in the sample: its exclusion represents a major drawback for the majority of previous papers. Thirdly, numerous test variables are defined in order to take into account the whole range of organisational approaches that can be implemented in a particular railway system: namely, vertical integration, vertical and horizontal separation, holding company and essential functions separation. These characteristics may denote this report as paradigmatic in respect to the topics covered and instruments employed, providing at the same time updated results on the effects of structural and liberalisation reforms. The results show that vertical separation generates positive effects on efficiency when train density and the share of revenues produced by freight traffic are low, whereas horizontal unbundling and holding model appear to reduce costs independently of other factors. Surprisingly, competition does not significantly affect the abatement of costs, underlining a potential limitation of the analysis due to the lack of precision concerning the attribution of this factor's impacts. In addition, horizontal separation advantages are described as partly produced by the sale of freight services, a benefit not strictly connected with the inner functioning of this structural reform. Another shortcoming may arise with regards to the computation of train density for each country, which is measured by using the sample mean when, in actual circumstances, this factor can greatly differ across regions.

Similar results are presented in the second updating contribution by Mizutani et al. (2014), wherein holding company, vertical separation and vertical integration are compared in terms of their effects on costs. In particular, taking into account holding company represents a significant novelty in the literature. Findings suggest that high levels of density and high proportion of freight transport on the network negatively affect the capability for vertical separation to reduce costs. Therefore, differences in individual railway systems need to be carefully considered, and a sole recipe may not be valid given the diversity of European railways. Free choice should then be

ensured for individual countries, especially in light of future market developments that would potentially determine an increase both in traffic - thus rendering vertical separation less convenient - and in new entrants' share - thus making holding company less appealing -.

These studies' findings manifest a stronger cost-reducing role played by horizontal separation rather than vertical separation, highlighted as well in the articles by Cantos et al. (2011) and Cantos et al. (2012) Therein, the interconnections between the two typologies of unbundling are scrutinised and evaluated to be beneficial.

In the first study (Cantos et al., 2011), data refers to 16 countries' railway industries over a long period (1985-2005) and is analysed by means of non-parametric methods (data envelopment analysis and Malmquist index). Passenger km and tonne km measure the outputs, whereas number of employees, rolling stock size, freight train supply[3] and number of km of railway network are categorised as inputs. Dummy variables are generated to take into account vertical and horizontal separation, as well as openness in the freight segments and "competition for the market" in the passenger services. Furthermore, control variables are defined to cover aspects that might contribute to explain the productivity change[4].

In respect to efficiency and productivity aspects, a noteworthy result can be traced in the relevance of the interaction between vertical separation and openness of freight market, together with a general positive influence of the totality of reforms. On the contrary, tendering methods appear to have scarce importance, possibly due to difficulties affecting their design.

The cross-countries results estimated over time exalt the benefits enjoyed by those countries which undertook a full process of separation (vertical and, above all, horizontal). These railway systems achieved the best performances in terms of efficiency, technical progress and productivity (namely, the Netherlands, Sweden, Norway and Denmark). In particular, technical growth is highlighted as the factor mostly contributing to the increase in productivity.

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[3] This corresponds to the annual fleet wagons strength for freight transport.
[4] These are:

- percentage of passenger train km of the total train km;
- quotient of the total number of train km and the number of km of track;
- average passenger occupation per train unit;
- average freight occupation per train unit.

Other relevant outcomes are the advantages created by the adoption of horizontal separation together with vertical separation, since solely implementing horizontal unbundling might generate lower performances for efficiency and productivity. Additionally, positive effects on productivity levels seem to be generated for those railway services with higher traffic density and occupation.

Technical change is also investigated, finding that vertical separation, when accompanied by tendering procedures, appears to promote this factor. Stronger technical progress is also achieved when horizontal separation is complemented by vertical separation, similarly to the results for efficiency and productivity.

As a conclusive note, the authors stress that accounting for the trends of a particular country does not modify the qualitative results obtained. From a policy point of view, the study appears to indicate that vertical separation might produce positive consequences with a view to the potential introduction of horizontal unbundling. Nonetheless these structural reforms had only been enforced in the years immediately preceding this study, leaving space for further research which could observe the performances of these measures on a longer period of time.

Slightly different policy implications surface in Cantos et al. (2012). This work is based on the econometric analysis of 23 European railway systems for the period 2001-2008. Passenger km and tonne km transported are chosen to measure the output side, whilst the input side consists of the number of employees in the sector, the rolling stock size[5] and the number of km of the railway infrastructure. In relation to the organisational structure of the railway market, dummy variables are employed with regards to vertical separation, competition in the freight routes, and liberalisation in the passenger segments in the form of tendering procedures.

Emerging from this study is the favour conceded to the combined enforcement of vertical and horizontal separation, potentially leading to improvements in efficiency. Comparing the results produced by the adoption of data envelopment analysis and two-step stochastic frontier analysis, the latter method gives account of relatively smaller levels of efficiency. However, when considering a ranking perspective, consistency emerges between the two approaches. More specifically, vertical separation appears

[5] This results from the number of available coaches, railcars, locomotives, wagons and multiple-unit trailers.

to produce little effects on efficiency, which instead turns out to be positively influenced by strong competition for passenger and freight services.

These outcomes are altered when a further variable is introduced, namely the dummy describing the implementation of the full reforming package. Strong emphasis is placed onto implementing the totality of reforms (vertical separation, “competition for the market” in the passenger sector and “competition in the market” for the freight sector), indicating how such an intervention might produce positive consequences on efficiency, possibly generated by the complementarities gained.

Overall, these two last studies underscore the benefits attainable from the enforcement of a complete process of separation or an even broader reforming package. Advantageous seems the implementation of vertical unbundling, which may exert conditions of ease with a view to the implementation of horizontal separation. Friebel et al. (2010) develop another notable work in this path, documenting the gains that a gradual application of a number of reforms may yield - referring to both vertical and horizontal separation, liberalisation of markets and presence of independent regulator -, in opposition to the disadvantages that a simultaneous adoption may cause. Similarly, Wetzel (2008) illustrates as inadequate the configuration emerging from an incomplete implementation of the totality of reforms.

Concentrating the attention firstly on the work by Friebel et al. (2010), a long interval is here taken into account (1980-2003), investigating the railway industries of 11 EU countries. Output is measured by passenger km and freight tonne km variables. Inputs are based on capital and physical elements, such as network (labour and land), additional labour and rolling stock. Moreover, deregulation aspects are accounted for by specific dummy variables, designed according to the number of reforms and to their temporal employment.

The estimates show a positive relationship between the regulatory interventions and the efficiency levels, provided that these are implemented gradually, since their simultaneous application might bring about negative performances.

Data unavailability constitutes a problem for this work too. Data for United Kingdom is not complete[6] and therefore not enclosed in most of the

[6] In particular, staff data for the period from 1995 to 2003.

regressions in the study. Further limitations concern the lack of control for the intensity of subsidisation, rather diverse across the countries, and the potential impacts of qualitative factors which are not considered when measuring the railway outputs.

In Wetzel (2008), the sample includes 31 railway firms from 22 European countries observed for the period 1994-2005, and the econometric methodology consists of a stochastic frontier analysis. A multi-output distance function panel model accounts for elements related to regulation, specific features of countries and companies, as well as temporal trends. Inputs here considered are the number of employees (annual mean), number of rolling stock and network length (in km), whereas outputs are measured by passenger km and freight tonne km. Exogenous aspects are also examined, with regards to specific characteristics of the companies[7] and countries[8].

Observing firstly the environmental variables, efficiency might be negatively affected by higher degrees of network and population density, whereas a wide presence of electrified lines might foster it. Moreover, from a macro-regional point of view, worse results are reported in Eastern Europe.

As for policy variables, a more efficient configuration might be reached when openness in the domestic freight market and an independent body for regulatory issues are present, whilst negative outcomes may emerge from liberalisation in international services and in domestic passenger markets.

The author provides explanations to justify the results on environmental and policy variables:

- The construction of electrified lines may generate a reduction in costs, determined by lower maintenance and coordination expenses;
- High density levels for population (and consequently customers utilising passenger transport in the same area) and network might provoke greater expenditures in connection with the management of routes;

[7] These are: network density (network length in km per square area km) and electrified lines (percentage of electrified lines in the total network length).

[8] These are: gross domestic product (GDP) per capita and population density. Also, a dummy variable is created in order to account for the differences between European macro-areas (West and East).

- Delay in Eastern Europe might be caused by the economic and technological reforms yet to be completed by the countries in this area;
- International services might be affected by difficulties regarding the cross-border activities, whilst the domestic passenger segment might suffer from more acute problems for journeys schedule and ticket clearing system than the freight one[9].

In respect to separation variables, the results are inconclusive, since the effects produced by these structural reforms mostly depend on the method of categorisation of the individual countries. Relevantly, those Western European companies affected by the worst performances in efficiency only adopted a few reforms (accounting separation and international access), indicating that the incomplete implementation of a reforming package might produce an unsatisfactory scenario.

Limitations affect this paper as well in terms of missing data, forcing the total or partial exclusion of the British, Danish, Dutch, Swedish and Estonian systems from the sample. Another technical difficulty, shared by Friebel et al. (2010), pertains to the distinction between actual and formal approval of the measures: the latter aspect is where the examination focuses on in these studies, determining results which are thereby affected by this temporal discrepancy.

Another reform deserving attention is the accounting separation between companies operating in network management and rail operations. This measure was analytically examined by Asmild et al. (2009). In this article, 23 European countries are observed for the period 1995-2001 in order to identify the impact of railway reforms through multi-directional efficiency analysis. The data is pooled to construct one common frontier, through which the authors can directly compare efficiencies, assuming that relative changeovers are only due to legislative innovations. Inputs are divided into discretionary (labour and material[10]) and non-discretionary (network length[11]), while outputs are measured by passenger train km and freight train km. In relation to dummy variables, five different policy indicators are introduced, reflecting accounting separation, complete separation,

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[9] The author notes that a stronger level of competition might offset these disadvantages.

[10] Capital and rolling stock are not enclosed due to data unavailability and accounting difficulties.

[11] Since network length, at least in the short-term, is not considered a decision parameter.

independent management, competitive tendering for passenger service, and market opening for freight transport.

Efficiency levels are argued to be increased by the reforms, especially in connection with accounting separation which might produce better results in reducing costs pertaining to both staff and material, affected only individually by other types of measures. As partial limitation, data was unobtainable for Bulgaria, Latvia, Lithuania and Romania which were therefore not enclosed in the sample.

Based on different interpretative standpoints, other authors investigate the reforms' impacts concluding that, especially in relation to vertical separation, disadvantageous effects in efficiency are produced. Therefore, discernible divergences surface in contrast with the policy implications highlighted by the previously reviewed works. Growitsch and Wetzel (2009), Jensen and Stelling (2007) and Merkert et al. (2012), albeit presenting dissimilar observations on the size of the impact, find vertical separation generating pejorative effects on efficiency. This negative impact contrasts with the benefits generated by other factors, such as deregulation interventions (Jensen and Stelling, 2007) and economies of scope (Growitsch and Wetzel, 2009).

The study by Growitsch and Wetzel (2009) analyses 54 railway companies from 27 European countries observed over the period from 2000 to 2004. Methodologically, the study is centred on a two-stage data envelopment analysis employing non-parametric and super-efficiency models. Outputs are measured by using train km (networks managers), passenger km (passenger rail operators) and tonne km (freight rail firms). Inputs are examined in two different analytical models, respectively including only physical measures, and monetary and physical measures at the same time[12]. For vertically separated contexts, the construction of "virtually" integrated companies conglomerates the data ascribable to every network manager with every railway operator (passenger and freight ones).

The two models, accounting for physical and monetary inputs, show that the majority of the actors in the sample present economies of scope; in particular, better performances are reported in the "monetary" model.

[12] Input variables are: number of employees, number of rolling stock, and network length. The first two variables are then replaced with the operating expenditure in the second model.

Significantly, the authors conclude that, on average, the integrated companies are more efficient than the “virtually” integrated companies.

Following the ranking established by the Rail Liberalisation Index Report (IBM Business Consulting Services and Kirchner, 2004), patterns are also identified. Railway markets in Spain, Greece and Ireland show the worst results in terms of liberalisation, and their integrated railway firms suffer from diseconomies of scope and low levels of efficiency. On the contrary, integrated railway firms acting in more liberalised markets (Germany, Italy and Switzerland) enjoy stronger performance, gaining in productivity thanks to economies of scope. Nonetheless, this outcome does not seem consistent since some countries with little rail liberalisation still enjoy economies of scope, highlighting the relevance of other factors such as privatisation, competitive experience, and rail modal share.

Future research paths are indicated, particularly related to investigating which directions the impact of the economies of scope takes, either vertical (network manager and rail operators) or horizontal (passenger and freight services), or both. Equally important might be to consider the significance of aspects inherent in railway quality and safety which commonly impact the structure of costs.

The analysis provided by Jensen and Stelling (2007) is based on a longitudinal econometric approach which takes into account annual data included in the period 1970-1999 for the Swedish incumbent Statens Järnvägar (SJ) and the set of remaining operators in this national market. Outputs are measured by passenger km and freight tonne km. For inputs, the authors exclude the depreciation of rolling stock and infrastructure expenses, thereby only considering aspects linked to operating, maintenance, administrative and marketing areas.

Vertical separation is argued to negatively impact on the efficiency level, whereas stronger competition generates an opposite outcome. Overall, the effect of deregulation appears to bring about a higher amount of benefits rather than disadvantages. The negative effects of vertical separation might be provoked by the rise in short-term costs due to restructuring necessities, as well as by long-run modifications of the cost structure. Moreover, lower efficiency might be linked to increased transaction costs and the sub-optimising conditions deriving from the unbundling process.

In relation to model limitations, it may be noteworthy to underline that cost data for some new small operators was not obtainable, determining the

exclusion of these actors from the dataset when approximations were not possible.

In Merkert et al. (2012), transaction costs are analysed in respect to the implementation of vertical separation in three countries: United Kingdom, Germany and Sweden. The sample includes 42 railway undertakings, observed during the year 2007. The sample is analysed thanks to a bottom-up method which, by detecting the particular interfaces where transaction costs arise, thereby permits their individual quantifications. This measurement not only covers the effective time spent by staff to reach a particular agreement, but also identifies the operating divisions involved in the transaction within the macro-area “infrastructure managers-rail operators”.

Overall results show that transaction costs caused by vertical unbundling allow for only about 2-3% of total costs, highlighting the possibility for this organisational structure to induce competitive benefits able to more than counter its negative impacts. This quantification does not account for costs incurred by network managers and railway operators in their relationships with regulatory bodies, even though the authors suggest that the related computation would alter only slightly the total transaction costs.

Looking at the measurements computed for each country, Germany seems to enjoy the most efficient configuration. Nevertheless, an overarching vision is necessary in order to consider parent company support and regulatory expenditures which might modify the ranking’s positions, depending on the level of financial interconnections within the German holding model.

Some operators’ data turned out to be unavailable, even though their absence does not corrode the integrity of the sample, which is deemed to be adequately representative of the countries’ systems. In addition, a methodological limitation affecting the bottom-up process is its inability to take into account different interfaces[13], as well as to distinguish between the costs for the monitoring of performances and the costs due to specific interconnections between network bodies and railway companies.

Further elements are highlighted. The effects of vertical unbundling on the overall efficiency levels might be considerable due to, for instance, restructuring costs. Moreover, the advantages of competition, if stimulated, need to be considered. Lastly, transaction costs should be monitored at

[13] For example, in relation to rolling stock manufacturers.

regular intervals in order to ascertain whether notable modifications have occurred with regards to their amount and significance.

Costs incurred while completing transaction activities are scrutinised in Merkert (2012) as well. Herein 46 undertakings across Sweden, Germany and Great Britain railways are analysed by means of a top-down approach. Transaction costs appear to only slightly affect the total operating costs when vertical separation is enforced, suggesting that this structural reform, if accompanied by competition, may offset the rise in costs by stimulating even slight benefits. This is attested by the finding on low transaction costs, which are on average around 10% of the total operating costs for the analysed companies.

The German holding model appears to have the lowest transaction costs, even though in that system greater parent support needs to be taken into account. Overall, the author suggests that the analysis may be valid for other European and non-European railway systems, provided they rely on the same structural forms considered by the study, namely holding model and vertical separation. The other form, separation of key powers, is less diffused around Europe and would presumably produce even smaller transactions costs, as characterised by smaller fragmentation than the fully separated model.

Supplementary research is suggested by stimulating the investigation of, for instance, the effective impact of labour on the level of transaction costs, the interface between network manager and rail operator, the characteristics of the decision-making process, and other typologies of cost, such as opportunity costs, incremental costs, one-off separation costs and risk costs.

2.3.2 Studies on the impacts on profiles different from efficiency

Shifting the attention on studies with analytical objectives different from efficiency, it may be particularly noteworthy to review the works by:

- Drew and Nash (2011) on traffic growth and competitive conditions;
- Preston and Robins (2013) on welfare effects;
- Drew (2009) on the freight segment.

The work by Drew and Nash (2011) importantly highlights the significance of the institutional, regulatory and financial conditions characterising the railway systems. The analysed countries belong to the EU, and are analysed separately both in terms of membership to EU 15 or to EU 12, and in terms of the size of their railway systems.

On rail freight, results give account of no correlation between vertical separation and greater competition, increased traffic and stronger modal share. This is implied by the smaller number of licences issued and slower pace associated with freight market growth observed when vertical separation is in place. Stronger results are instead detected in respect to the passenger segment, but this is indicated not to be ascribable to vertical separation[14]. As policy recommendation, the authors illustrate that other factors should be assessed when investigating railway reforms, particularly referring to: the regulation environment; the financial conditions of the incumbent; the existence of services of public interest; and the governmental support in infrastructure interventions. This wider approach may allow identifying the quantitative elements strictly associated with vertical separation, and defining the impacts that this structural reform produces in a more isolated way.

The public control regime on railway companies (network manager and operators) is assessed by Preston and Robins (2013), who stress how a more rigorous approach in the way the British rail system was monitored after the Hatfield accident in 2000 determined negative impacts on welfare. Based on the British rail passenger segment, the econometric analysis aims to forecast its demand and its components, accounting for - on the inputs side - the infrastructure and train operating costs, and - on the outputs side - passenger km, real revenue per passenger km, train km. Further variables include real GDP and dummies for privatisation, Hatfield accident and strikes.

Vertical and horizontal separation appear to produce disadvantageous effects on welfare which, overall, declined after Hatfield accident, when public control on network manager and rail operators became stricter. Reforms augmented the complexity of the system, producing a rise in costs (transaction costs, diseconomies of scale and principal-agent-related costs). Also, regulatory failures are pointed out in respect to the low level of investments in infrastructure. Limitations are underlined in terms of the construction of the counterfactual, which does not capture the increasing

[14] In particular, growth of passenger traffic and modal share are reported for United Kingdom, France and Spain (vertically separated contexts on paper). Nonetheless, the authors point out that the British system is predominantly based on franchising, allowing for open access operations, while the national operators in France and Spain are the sole serving the passenger routes.

costs in infrastructure operations in the aftermath of privatisation and, above all, the Hatfield accident.

This multi-faceted approach is also emphasised in Drew (2009), in which open access and vertical separation are compared by computing the respective benefits on customers of freight services. Three virtuous countries are taken into account on the basis of the top level of liberalisation reached by their freight markets: Germany, Sweden and United Kingdom. In particular, the British scenario is analysed more in detail in terms of the restructuring process affecting the freight segment.

Liberalisation, in general, is argued to have produced greater advantages in terms of traffic growth in these three countries than what was achieved in non-liberalised countries. Vertical separation seems to deliver better outcomes for freight customers than open access to market, even though the British study (where both measures were enforced) highlights how this structural reform might increase other types of cost (such as infrastructure and transaction costs).

In conclusion, the regulatory interventions on railways are described as resulting from policy-making processes involving numerous institutional, market, scale, scope and technical factors, delineating a complex scenario where these aspects may change within the same country.

2.3.3 Discussion

This Section provides a discussion of the limitations, results and further paths of research that the review of the above studies induces to consider. In the first part, the focus will be on the limitations affecting the methodological approaches (Section 2.3.3.1), while the second will discuss the differences in results (Section 2.3.3.2).

2.3.3.1 Methodological limitations

Many studies underscore the difficulties encountered in benefitting from correct measurements for inputs and outputs. Mizutani and Uranishi (2013) presents a measurement for energy components - energy consumption and energy expenditures - which had to resort to fuel consumption data provided by Eurostat, partly because of the variety of energy sources utilised

(resulting in the employment of the tonnes of oil equivalent (TOE) variable), and partly because of the deficiencies affecting the original data source[15].

Also Wetzel (2008) highlights how energy data turned out to be unavailable, countering this by assimilating energy to rolling stock, on the basis of their close relationship. In relation to the outputs, the choice towards using passenger km and freight tonne km is argued to be able to include governmental restrictions on capacity allocation into the analysis, overcoming the limitations of other measurements (such as passenger train km and freight train km).

The distinction on the measurements of the inputs in the two models analysed by Growitsch and Wetzel (2009) - only physical quantifications in one model, and both physical and monetary quantifications in the other model - leads to some reflections on the benefits and drawbacks characterising both approaches. Physical measures do not permit to detect the changes in relative factor prices at international level, whilst the monetary examination faces issues in respect to different price levels, accounting regulations, and currency conversion. Manipulating the financial data of operating costs into the purchasing power standard - a common currency purposely created - represents the solution adopted by the authors, who employ purchasing power parities indicated by Eurostat in order to control for currency conversion, differences in price levels and purchasing powers of the analysed countries. Counterbalancing these enhancements are the problems due to different accounting rules which do not appear to be resolved, calling for further analyses able to account for the variety of policies implemented in this area.

Interesting and comprehensive are the explanations presented by Jensen and Stelling (2007) with regards to the selection of the cost variables, the data adjustments performed, and the construction of an input price index.

From the operating costs, the authors exclude the depreciation of rolling stock and the infrastructure costs, defining this latter element as including the totality of costs incurred by the network manager except those for new investments and re-investments in railway tracks. Moreover, a list of interventions on the quality and quantity of data pertaining to the former Swedish monopolist is designed, including:

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[15] The original source is *International Railway Statistics*, issued yearly by International Union of Railways (UIC). Energy expenditures are included within material expenditures in UIC data.

- Statistical interpolation method used for the purpose of filling the gaps for those years in which infrastructure costs are missing;
- Modifications in the description of investment in tracks and real estate which, until 1981, was considered as network operating costs whereas, after 1981, it became part of the set of investments not inherent in maintenance and replacement activities;
- Tackling the potential presence of “creative accounting” as a consequence of the implementation of vertical separation after 1988, which might have led to artificial estimation of costs for the new organisation aimed to provide better initial conditions.

Lastly, similarly noteworthy appears the elaboration of an input price index. Considering labour, capital and electricity costs, an aggregate index is obtained by adding the individual price indices multiplied by weights defining the average input cost shares. The growth of the cost shares, for the objectives of the work, should result uniform in the temporal interval. Here other difficulties potentially arise, in terms of accounting for outsourcing activities, reclassification of costs and organisational fragmentation, all of which might complicate the calculation of the degree of change.

Another distinction that might result problematic to define is presented by Asmild et al. (2009), when some typologies of infrastructure costs are observed (for instance, maintenance) and potentially categorised as variable or capital expenditures. In addition, capital or rolling stock is not included in the analysis due to the lack of data in the original source[16]. Besides this, the various depreciation rules utilised by the countries under examination corroborate this choice.

In Merkert (2012), the measurement of labour encounters analytical burdens. Labour input is indeed based on the estimation of its potential capacity, less accurate than the realised capacity, which is however more difficult to measure. This does not allow the highest level of accuracy in quantifying the key element of this paper, namely the transaction costs.

As a last contribution on this topic, in van de Velde et al. (2012) some difficulties are described in respect to the measures of rolling stock and diverging international depreciation rates. With regards to rolling stock, this

[16] The original source is NERA Economic Consulting. Utilising other datasets would have been impracticable according to the authors, as this data would have been inconsistent and incompatible with NERA data.

variable is calculated as the sum of numbers of vehicles of differing types, which however display different characteristics. The authors therefore consider that this procedure might negatively affect the computation of materials input prices, when rolling stock is selected as denominator. The issue on depreciation rates, as previously illustrated for other references, represents a common problem in this report as well, even though this is indicated to be partially controlled for by including capital input prices in the model.

2.3.3.2 Differences in results

Remarks concerning the quality of the studies' results can be presented following two main groups:

- On the one hand, the results on variables intrinsically related to the railway reforms;
- On the other hand, the results on variables not directly connected with the railway reforms.

Illustrating the former group, a relevant breakthrough in the composition of the samples is attained by van de Velde et al. (2012) report which removes previous works' shortcomings deriving from the exclusion of United Kingdom. This study tackles another problem, by accurately identifying the moment of the implementation of the reforms that, in some papers (Wetzel, 2008 and Friebel et al., 2010), is replaced with the moment of their promulgation, generating potentially misleading implications.

Among individual reforms, difficulties surface when the measurements of respective effects turn out to be overlapped, thereby hindering their precise quantification, as in van de Velde et al. (2012, particularly for competition), Cantos et al. (2011), Friebel et al. (2010). In addition, further directions can be undertaken towards deeper analyses on:

- Vertical separation effects in individual countries - especially in relation to those contexts where train density hugely varies across regions and traffic from freight services is significant (van de Velde et al., 2012) -;
- The examination of the relationships arising between railway undertakings and infrastructure managers, ranging over transaction costs, which should be constantly monitored (Merkert et al., 2012), as well as other typologies of cost, as indicated by Merkert (2012).

Taking into account the latter group on results on variables indirectly referable to railway reforms, many authors stress the importance of the

inclusion of profiles associated with institutional, regulatory and financial conditions. This is particularly meaningful when assessments are needed on phenomena of subsidisation (Friebel et al., 2010), on quality and safety costs, and on the impact of rail modal share (Growitsch and Wetzel, 2009).

Similarly, when the intervention of the government is decisive in infrastructure operations or in the identification of segments of markets aimed to serve public interests (Preston and Robins, 2013 and Drew and Nash, 2011), its effects deserve appropriate investigations.

Lastly, noteworthy is the existence of a pattern based on the relationship between the sample and interval selection, and the findings obtained. To clarify this, the studies highlighting the disadvantages of vertical separation - Growitsch and Wetzel, 2009, and Jensen and Stelling, 2007 – will be firstly considered. In the former study, the dataset comprises multiple European undertakings and the period of observation is relatively short (2002-2004). On the contrary, in the latter study only one system is considered (the Swedish one), but more decades are taken into account (1970-1999). A more homogenous configuration emerges in respect to those studies which, although with important differences and dependent on relevant conditions, indicate the impact of vertical separation to be potentially advantageous. For instance, the studies by Mizutani and Uranishi (2013), van de Velde et al. (2012), Cantos et al. (2011) and Cantos et al. (2012) are characterised by rather large samples - oscillating from the 16 EU companies analysed by Cantos et al. (2011) to the 33 European and Asian railway systems assessed by van de Velde et al. (2012) - and similar chronological intervals - each of them covering at least eight years -. Even though a partial degree of analogy might be hypothesised, vertical separation spreads its potentially beneficial impacts through magnitudes and conditions which at times strongly differ among these works. In addition, the termination of the periods analysed in the articles deserves to be investigated, because it might occur when the implementation of a specific reform is still undergoing.

2.4 Conclusions

Comparing the various studies, contrasting outcomes are reported in the literature in particular regarding the impacts of vertical separation. van de Velde et al. (2012) and Mizutani et al. (2014) find vertical separation carrying beneficial repercussions when train density is low, while horizontal unbundling appears to produce cost reductions irrespective of other aspects. Cantos et al. (2011) and Cantos et al. (2012) report instead the existence of

a linkage between these two structural reforms, claiming that positive effects can only be generated when both of them are implemented (together with freight market openness in the former paper). At the other end of the spectrum, vertical separation seems to be detrimental according to Growitsch and Wetzel (2009), Jensen and Stelling (2007) for the Swedish system only and, in terms of transaction costs, Merkert et al. (2012).

Looking at the findings specifically on regulation, even in this case the results slightly differ in the few studies analysing this profile. While Wetzel (2008) recommends the introduction of an independent regulator as able to create positive repercussions on costs, Friebel et al. (2010) trace similar benefits, especially when this reform is accompanied by sequential reforms involving vertical and horizontal unbundling and open access to market. Overall, the study of the regulatory effects appears superficial, reflecting the lack of sophisticated methods for measuring regulation in railway-related studies.

In general, a number of limitations affecting studies in railway reforms have been overcome thanks to some recent works, especially Mizutani et al. (2014) and van de Velde et al. (2012). The composition of the samples, for instance, now benefits from the inclusion of United Kingdom, arguably the country in which rail reform has been carried furthest (United Kingdom is excluded in most of the other studies). Moreover, the mixed results regarding individual reforms appear to be dependent on specific factors. In particular, with vertical separation, perhaps the most divisive among the reforms, the role played by density, as pointed out by van de Velde et al. (2012), may hugely vary across regions and needs to be carefully assessed. Freight traffic as well brings repercussions on the effects of vertical separation, deserving deeper analyses in relation to its variability.

Lastly, further issues concern elements directly or indirectly related to the reforms. In the first group, the correct consideration of transaction costs between the different interfaces of a railway system (regulators, infrastructure managers and railway undertakings) should be mentioned, as explored by Merkert et al. (2012). In the second group, the analysis of the reforms' impact should also aim to incorporate profiles associated with institutional, regulatory and financial systems, accounting for phenomena such as subsidisation (Friebel et al., 2012), and governmental power on infrastructural operations and on the provision of routes serving public interests (Preston and Robins, 2013 and Drew and Nash, 2011).

In this Chapter, the impacts of railway reforms were predominantly investigated with regards to the analytical objective of this thesis, namely railway efficiency. Further profiles were also taken into account, such as modal share and welfare. Importantly, this review pointed out that the effects of the reforms have been mixed and, especially for vertical separation, contrasting views on its advantages have emerged. Considering the objective of this thesis, the attention dedicated by these studies to the reforms on economic regulation and on the regulators' role has been rather limited, in terms of both measuring and tracing regulatory impacts. Here lies the rationale behind this research, which will analyse the regulatory effects in a more in-depth and precise manner than what was carried out in the past.

In order to do so, the next Chapter will present findings on the way regulation is measured in works on comparable network industries, since those in railway economics have tended to utilise rather simplified dummy variables. Focus will also be concentrated on another type of literature review, attempting to define what determines an ideal regulator in railways. This will be relevant for the design of the questionnaire on rail regulation (Chapter 4), central to the qualitative analysis of this thesis (Chapter 5). On the quantitative side, the evidence described by the literature reviews on the impacts of railway reforms and on measuring regulation greatly contributes to the methodological choices explored in Chapter 6, based on the construction of a composite regulation index which will form integral part of the econometric analysis (Chapter 7). Ultimately, the findings resulting from the quantitative and qualitative analyses aim to illuminate the magnitude and trend of the role played by economic regulation and regulators within the European railway systems.

Chapter 3
Literature review on ideal rail regulator characteristics

3.1 Introduction

The previous Chapter explored how several studies analysed the impacts on railway reforms on different profiles, particularly concentrating on efficiency. It also pointed out the little attention on reforms affecting economic regulation. Therefore, dedicating more focus on this type of reform would complement the literature, by taking into account not only the role played by rail regulators but also the interrelationships between economic regulation and interventions on the structure and competition of railways.

A first attempt in this direction will be carried out by delineating how regulation is measured in studies on comparable network industries, given the rather simple methods adopted by railway-related works. This Chapter also moves forward by considering what is implied by the role of rail regulator, in particular by looking at the related ideal characteristics. This assessment will constitute the necessary foundation sustaining the design of the questionnaire on rail regulation in the next Chapter, central for the qualitative analysis of this thesis. In particular, the research of ideal rail regulator characteristics will help to determine how European regulators perform against these ideal benchmarks, and which patterns, practices and deficiencies can be identified. The emerging evidence, together with the econometric estimates incorporating a newly developed regulation index, will provide a comprehensive view on how the regulatory role has evolved, which impacts has produced, and which areas are in need of improvement.

The ideal rail regulator characteristics will be traced by reviewing studies and industry reports looking at the role played by regulators in railways. Contributions will also be discussed in respect to general regulation theory, and studies on transport or network industries. Importantly, the reviews on how regulation can be measured and on the ideal rail regulator characteristics will be preceded by focusing on what is implied by the concept of economic regulation in railways, observing the theoretical background and which operational models have been adopted in Europe.

Section 3.2 will explore the notions and models behind economic regulation in the railway industry. Given the little attention of the literature on railway economics over economic regulation, Section 3.3 will provide insights on how to measure regulation emerging from studies on comparable industries,

and explore the rationale behind the research. The literature review on the ideal rail regulator characteristics will then follow in Section 3.4. Conclusions are presented in Section 3.5.

3.2 Economic regulation in railways

Regulators have been playing a significant role in the European railways industry for quite a few years. Since the legislative wave inaugurated at the beginning of the 1990s by the European Commission, the introduction, renewal and strengthening of regulatory roles have been of primary importance among the railway reforms implemented continent-wide. Nevertheless, as explained in the previous Chapter, this type of measure has attracted little attention by the literature on the impacts of railway reforms, concentrating more on structural and market interventions, such as the effects of vertical separation and higher levels of liberalisation. Given the powers and autonomy granted by continental legislation, the current conditions controlling the activities of rail regulators will be explored, for the purpose of filling the gap in the literature, and ultimately de-constructing and discussing the role played by regulatory bodies in the European railway industry. Thus this work, by moving from a rather simple way to account for regulation utilised by previous studies, aims to provide an in-depth, bottom-up analysis able to document the state and direction of practices in rail regulation around Europe. In order to offer background to this analysis, the current Section will attempt to define what is implied by the concept of regulation in railways, while the next Sections will focus on describing how regulation can be measured and on capturing ideal characteristics of the rail regulator's role.

The necessity of a regulatory presence in railways is explained by multiple factors. To analyse these, a few notes should be formulated on relevant reforms which have shaped the industry. Firstly, the European Commission has legislated on the separation of infrastructure and operations, if not at organisational level, at least at the accounting one. A full unbundling is defined as vertical separation, while at the opposite end of the spectrum lies vertical integration. At an intermediate position, a holding company represents a configuration where the accounts and management are separated but the different bodies all belong to the same mother company.

Secondly, non-discriminatory practices have become the highroad to pursue in respect to the formalisation of the infrastructure managers' processes and decisions. As a matter of fact, these bodies hold prominent powers related to

the allocation of capacity and the setting of charges. The inherent decision process should avoid producing advantageous (or disadvantageous) conditions for particular railway operators, whose influence is intended to be minimised.

Thirdly, competition in this sector has increasingly strengthened in the last decades. Freight is the sub-market within which competitive conditions have been mostly incentivised and promoted (Second Railway Package, 2004). Passenger transport was instead impacted by pro-competitive provisions only more recently (Third Railway Package, 2007) and, as opposed to the complete openness of the freight segment, currently only requires an open market for international services. However, some countries have gone beyond this in opening the market either through competitive tendering or open access.

This pattern shows the importance of the regulatory presence in the following ways. The implementation of vertical separation in a number of European countries involves the emergence of important interactions occurring between disjointed interfaces, namely the infrastructure managers on the one hand, and the railway undertakings on the other. These interactions are typically related to investment strategies, capacity allocation and timetabling, as well as real-time operations, creating an interdependent environment for railway undertakings, infrastructure managers and (at times) governments. If with vertical integration (and to some extent within the holding company model), the costs emerging from transaction costs are argued to be small because the interactions are between entities sharing the same business interests, with vertical separation these costs are likely to reach greater levels, since the parties involved are placed on opposing positions, and the possibility of reaching compromises is inevitably reduced. However, direct transaction costs do not seem to be great in railways (as shown by Merkert et al., 2012); what seems to impact more heavily are the costs arising from misaligned incentives and the potentially suboptimal decisions thereby created (see van de Velde et al., 2012). In this scenario, as pointed out by Finger and Messulam (2015), regulators could act as impartial third parties aiming to minimise transaction costs, and the associated wider problem of misalignment of incentives. To be effective, the regulatory role should require a strong independence from governmental or, more in general, political influence, when the negotiations involve railway undertakings or network managers controlled (directly or indirectly) by the government.

In these structurally unbundled contexts, regulators can also be relevant in terms of obtaining the desired levels of efficiency by the railway system as a whole. Infrastructure managers may indeed be less incentivised onto the efficient use of the available resources, in contrast with more integrated models, where the efficiency reached by the network managers, by impacting on railway undertakings' activities, also produces consequences on the mother company grouping all these entities. In separated models, this shared interest tends to fade, and railway undertakings may turn to regulators which could be enabled to exert that necessary pressure on the infrastructure managers to improve efficiency.

This potential capability also surfaces by looking at a pivotal reform on the regulatory role (the Recast), delineating the regulatory powers related to the control of the performance of the infrastructure managers, which may involve the quality and efficiency of the services provided. From the point of view of quality, regulators' actions could be directed towards the safeguard of adequate levels of performance in areas such as track maintenance and strategic investment planning. From the point of view of efficiency, the charging system might require the approval from regulatory bodies, which also seek an optimal allocation of the resources through the preservation of non-discrimination.

Different effects arise from these regulatory operations. While the regulators' control of the infrastructure managers' performance and efficiency produces direct effects on costs, monitoring non-discrimination only indirectly might impact on the efficiency of a railway system. Within this latter area another regulatory activity can be included, namely the promotion and strengthening of competitive conditions. Through the resolution of disputes on competition and, more generally, the prevention of practices deviating from this objective, regulators might play a role in ensuring that potentially more efficient players are allowed to enter the railway arena, thus also putting pressure on the incumbent to become more efficient. Nevertheless, it should be borne in mind that within the railway sector, freight services are denoted by greater levels of competition, in comparison with passenger ones. Therefore, if the above observations on regulators and competition may express a certain practical implication for the freight sub-markets, it is much more limited for the passenger segments.

For these segments, the promotion of competitive conditions by means of regulatory pressure on local and national decision makers appears to be the principal way to ultimately increase the competition in rail transport, together

with improving the levels of efficiency. Passenger markets are typically distinguished between commercial segments and routes covered by public service obligations: while for the former “competition in the market” represents the most common approach, for the latter forms of “competition for the market” need to be conceived and implemented to increase contestability. In phases connected to, for instance, the design of tendering procedures and their enforcement, regulators can support and actively participate in the related tasks. At the same time, these bodies can oppose discriminating modalities of capacity allocation aimed to minimise competition and favouring certain actors, potentially occurring when direct awards are utilised.

Institutionally, in order to obtain these goals, three rail regulatory models have been developed in Europe (see IBM Business Consulting Services, 2006; Crozet et al., 2012): the ministry model (Model 1), the railway authority model (Model 2), and the special regulatory authority model (Model 3). The first set comprises those countries in which the Transport Ministry plays the role of the industry regulator, or in which the absence of an authority requires the ministerial action in order to grant investigative powers to ad hoc bodies each time the need arises. The requirements for independence of the Recast made this model illegal, but it has been prominent during the period of the analysis. In the second group, a regulator is part of a railway authority, namely a body responsible to government and mainly involved with licensing, safety, and administrative activities rather than access regulation, for which it normally is scarcely equipped. If this type of body is enhanced in terms of independence and specialisation in regulation, and is given decision-making powers, it is then included into the third model, characterised also by the presence of staff exclusively working on economic regulatory issues. As part of this third model, it should be also noted that a number of European rail regulators are placed within bodies not exclusively dealing with railways, ranging from multi-industry to competition authorities.

Numerically, the special regulatory authority model (Model 3) has become more popular in recent years. This institutional form is now present in twenty countries, as opposed to seven countries in 2006 (IBM Business Consulting Services, 2006). The remaining nations adopted the railway authority model (Bulgaria, Estonia, Hungary, Lithuania, Slovakia and Norway), while a few still have a ministerial body or no regulator at all (Switzerland and Ireland). Those countries not fully complying with the current legislation are relative new comers in the EU, or only belong to the European Economic Area

(EEA), or in the case of Ireland have a railway system not geographically integrated with the rest of the European network.

The literature on the impact of railway reforms has dedicated little attention to this regulatory changeover, concentrating on other aspects, as documented by the full review in the previous Chapter. This lack is being tackled by this thesis which, as a result of the regulators' updated functions, will quantitatively analyse the impacts of economic regulation on railway efficiency and qualitatively discuss the current regulatory practices. The former task is centred on the employment of a purposely developed regulation index, whose methodological choice naturally follows what emerges from the next Section on measuring regulation in non-railway but comparable industries. The latter task builds on responses from European regulators, infrastructure managers and railway undertakings to a specifically designed questionnaire. Significantly, the questionnaire design takes into account ideal rail regulator characteristics, against which European regulators' performances are measured. The literature review tracing these ideal characteristics is presented in Section 3.4.

3.3 Measuring regulation

As noted in the previous Chapter, the role of regulation has been investigated by a few studies and typically through the lens of the presence of an independent regulator, measured by dummy variables. This is traceable both in the papers previously examined and in studies performed in respect to non-railway but comparable industries.

This is the case for Barros et al. (2010) who, in their study on the Japanese air sector, allow the regulatory variable to change value according to observations recorded when yardstick regulation was and was not in place, also determining the impact of the induced modifications on an output measure for aviation management. A similar approach is followed by Soderberg's article (2011) on Swedish electricity distribution, in which a dummy variable is created to account for the enforcement of incentive-based regulation, as part of a cluster of firm-specific exogenous aspects. The independence of the regulator is instead the principal focus of the studies of Quiros (2011) on the European postal sector and of Wallsten (2001) on telecommunication markets in Africa and Latin America: the related regulation dummies oscillate between 0 and 1, reflecting the opposite emerging scenarios. The latter author also points out that supplementary information is needed and would be beneficial in respect to the typology of

regulation enforced, the organisational and financial characteristics, and the competencies of the authority. This deeper level of assessment may be achieved through employing more sophisticated instruments, such as the nonlinear function in the work of Marques and Barros (2011) on European airports' performances, where regulation is explained by including transaction costs and influence on managerial ability as arguments.

The formulation of indices is to the same extent an accurate device able to cover the width of aspects inherent in regulatory role and activities. Sound examples of using indices are particularly traceable in the works of Zhang et al. (2008) on the electricity sector and Grajek and Roller (2012) on telecommunications. In Zhang et al. (2008), the regulation variable is based on a four-component index accounting for the regulatory governance in the electricity sector and attesting the presence of: electricity or energy regulatory law, independent regulator, fixed-term appointment for the management of regulatory agency, and authority's funding deriving from licence fees and levies or from government sources. While the first three component of the index are dummies, the fourth assumes values between 0 and 1, varying from total funding from government to complete self-funding.

The model elaborated by Grajek and Roller (2012) considers the incumbent, multiple entrants and the regulator, and the decisions of each are assumed to be dependent on the actions of the other actors. Three equations are constructed in order to describe the dynamic relationships between the intensity of regulation in a given domestic market, the infrastructure stock of the incumbent, and the sum of the stock of entrants' infrastructure (as well as entrants' individual investments). This design is intended to provide the linearised first-order conditions of a static investment game, where the choices on the level of infrastructure and regulation are formulated as a best response to what is selected by other agents. This setting evidently highlights the interrelationships between market structure and economic regulation which need to be considered when measuring the impact of regulatory activity.

The references here discussed attest the degree of depth of the various methodological instruments available. A dummy variable, albeit based on a simpler elaboration (e.g. Wetzel, 2008 and Friebel et al., 2010), faces some difficulties when the regulation scenario involves several factors which cannot be all comprised into a particular driver, like the independence of the agency. Further characteristics of the regulator concerning, for instance, its powers and the nature of its processes need supplementary ways of

explanation, which can be represented by the employment of a number of dummies ultimately assembled in an overall index. The works of Zhang et al. (2008) and Grajek and Roller (2012) are exemplary in this sense, as they highlight how multi-faceted the regulatory configuration might be in a specific sector. In this research, the construction of a regulatory index, taking account of the different regulatory aspects, plays a decisive role in the analytical determination of the impact of the railway reforms on efficiency. Starting from the technical indications emerging from railway and non-railway literature, the methodological plan is designed to absorb the regulatory factors into a general index to be employed as part of the explanatory variables of a total cost model. Two studies represent the cornerstones around which this activity will be conceived: the Rail Liberalisation Index reports by IBM and Kirchner (published in 2002, 2004, 2007 and 2011), and Mizutani and Uranishi (2013), whose contribution is deeply delineated in Chapter 6.

On the basis of the literature findings, the research questions for the quantitative analysis are set as follows. What is the impact of regulation on the efficiency of European railway systems? In order to do so, it is also important to ask how a regulation variable can be measured in railways? This thesis proposes to fill these gaps in the literature by quantifying regulation through a newly developed index and studying its impact on rail efficiency thanks to the estimation of a total cost function and the related system of equations. Besides this quantitative investigation based on econometric estimates, a qualitative analysis will also be carried out, building on the responses to an ad hoc questionnaire on rail regulation. The literature findings around which this questionnaire is designed are detailed in Section 3.4. Overall, the derived results, from the quantitative and qualitative analyses, will help to shed some light on the role of regulation and understand its interrelationships with structural and competition profiles.

3.4 Literature review on ideal rail regulator characteristics

The regulatory role in rail implies multiple characteristics which have been little analysed by the literature. In order to close this gap, this Section will provide a review of those characteristics which may be considered ideal for a rail (or transport) regulator.

These “ideal characteristics” originate from a review of the literature on the role and operations of regulatory bodies, as well as its interrelationships with the government and the various types of stakeholders (such as regulated

companies, trade unions, local public administrations and incumbent). From the moment of creation of the regulatory body, important factors should be considered. As explained by Fleck (2000) with regards to general regulation theory, the timing of introduction of the regulator in a national system is to be carefully engineered. The emphasis should not be placed on the automatic creation of bodies which elsewhere have guaranteed the success of the reforms, but on their staggered establishment depending on the different development stages of a system. This implies that a railway regulator may not be required until the market has reached a certain level of competition. The relevance of the context in regulation is stressed by Gassner and Pushak (2014) as well, who point out the necessity to adapt regulatory structures to the economic, political and sectorial conditions in which the agency would operate. Therefore, regulation studies need to take into account the context, and this research aims to embody this prerogative in the analysis of the European railway industry, wherein various and, at times, extremely different national characteristics coexist.

Another strand in general regulation theory examines the following stage, when the regulator has been established. The impact of enactment costs, necessary to implement a new policy, is obviously important to the choice between regulating and maintaining the status quo (Stephenson, 2007). Having a priori preferences also matters when the government is considered, especially when the executive limits the regulatory action to the mere ratification of governmental decisions, ultimately restricting the regulator’s possibility of growing and developing its own expertise.

A third strand looks into the informational asymmetries affecting any regulated market. In this framework, Fremeth and Holburn (2010) point out that the minimisation of regulatory capture could depend on three factors: the long regulator’s experience, the large number of staff and the existence of similar policies previously implemented by other agencies. In particular, Macher et al. (2011) underline that the previous experience and intensity of staff training are indicative of regulators’ heterogeneity in terms of their capability to minimise the information asymmetry gap. Ultimately, these particular circumstances surrounding the regulatory actions would determine the impact that economic regulation can have on the organisational structure adopted by the regulated companies (Levine, 2011).

Specifically to railways, an important study in this area was produced following an OECD Round Table discussion of experts on the role of economic regulators (OECD/ITF, 2011). Central in these references is the

focus on the significance of independence, which in turns depends on several factors. One of the primary objects of the regulator should be the pursuit of non-discrimination, connected with situations in which particular operators enjoy advantageous conditions for the access to relevant infrastructure. To achieve this, the regulator needs to be provided with appropriate human and financial resources and be accountable for its decisions thanks to a clear distinction between its responsibilities and the government (or other agencies) ones. The way the regulator reaches its goals is ideally transparent, publicly displaying the process and the results that substantiate specific decisions. Moreover, minimising the frequency of planning modifications in relation to infrastructure or transport services, and avoiding bowing to short-term political aims, confers stability and predictability. Lastly, an ideal regulator would be able to intervene on issues on its own initiative (and not only when requested by regulated firms), thereby growing autonomous capabilities.

Besides these points, and observing another network industry like telecommunications (OECD, 2000), regulatory oversight is better achieved by a collegiate body (i.e. board) rather than by a single person, and the related members should maintain their roles only for fixed staggered terms. Moreover, an external body should report on the activity carried out by the regulator, in order to evaluate its performance.

On this last topic, Niemeier (2011) signals the importance of the cost-effectiveness of a regulator, the objectives and procedures of which should be monitored by a third party through a cost-benefit analysis. The significance of the cost-effectiveness analysis is highlighted by Ponti (2011) as well, especially in terms of the presence of transaction costs attributable to the regulatory activity.

Further indications on how an ideal railway regulator should look like may be extrapolated from the recent Recast. The legislation now confers on rail regulators competences regarding the monitoring of access to and charging system of the pertaining railway market, with a view to generate adequate levels of contestability and competition. Also, the possibility of requesting data and information on accounting documentation, track access charges and financial performance of the infrastructure managers is deemed as a relevant regulatory power. Besides these, the formalisation of an effective sanctioning scheme should be seen as essential as well.

Among these, a particularly important legislative innovation is represented by the powers of demanding data on efficiency and on the multi-annual

financial equilibrium from the infrastructure managers (as suggested by the Recast). Since only in a few countries does the regulator seem to play an active role on efficiency control, the European experience in the rail sector turns out to be limited. Lessons could be learnt from practices employed in comparable network industries: in the energy sector for instance, the related extensive literature (Haney and Pollitt, 2009, 2011 and 2013) reports findings on the international diffusion (and related issues) of benchmarking methods, such as frontier-based and average benchmarking.

Some of these aspects have also been investigated by the Rail Liberalisation Index reports produced by IBM and Kirchner (2002, 2004, 2007 and 2011). These studies provide an overview on the state of the liberalisation processes in European countries, constructing indices and formulating rankings in order to evaluate which countries are denoted by advanced, scheduled and delayed progress. Even if the aim of these reports is not only centred on the regulatory state of each country in the sample, some of the drivers selected by the authors reflect and confirm the adequacy of the previously described findings. This can be observed by considering drivers covering the general aspects of the authority (including elements like independence, accountability and transparency), the object of the regulation (for instance, the responsibilities deriving from different types of inspections), and the regulators' powers (involving the possibility of imposing coercive means, or the range of investigations that can be performed). Another important study on rail regulation was produced in 2006 (IBM Business Consulting Services, 2006), where a survey was conducted in order to assess the regulatory conditions of rail network access in Europe. The areas therein investigated (such as general powers, scope and organisational aspects of the regulators) are also covered in this research, by means of a purposely developed questionnaire on rail regulation. Analysing the related responses aims to update past results by accounting for alterations occurred in the last decade, as well as complementing the research on this field by including those characteristics describing an ideal rail regulator.

On the basis of the findings extrapolated from the literature review, the research questions for the qualitative analysis are set as follows. How are the European rail regulators performing in terms of these ideal characteristics? What are the current regulatory trends characterising European railway systems? This thesis proposes to fill these gaps in the literature by constructing a questionnaire able to capture the extent to which rail regulators possess the ideal rail regulator characteristics, and by

analysing the collected results from a sample of regulators, infrastructure managers and railway undertakings across Europe.

These qualitative findings will complement the quantitative results based on econometric estimations of the regulatory effects, whose rationale was explored in the previous Section. The combination of these qualitative and quantitative activities will create an overarching analysis on the effects of economic regulation on the cost efficiency of European railways.

3.5 Conclusions

This Chapter examined what regulation in railways implies, how it can be measured and which characteristics ideally substantiate the regulatory role. Theoretical notions on the importance of regulation in railways have been provided, together with indications on the operational models previously and currently adopted in Europe in order to conform to legislative reforms. This was followed by two literature reviews, substantiating the methodological choice of adopting an index and detecting the ideal rail regulator characteristics to include in such an index. The overall evidence, innovatively in railway economics, enables to define how to measure the regulatory activity and what is expected by a regulator in railways in terms of its structure, operations and powers.

The findings emerging from these literature reviews have been utilised for the two principal tasks of this thesis. Firstly, to undertake econometric analysis centred on the impacts of economic regulation on railway efficiency. The related methodological design and quantitative results will be presented in Chapters 6 and 7. Secondly, to design a questionnaire on rail regulation which, sent to different actors in the European railway industry, has allowed determining how European railway systems perform in terms of an ideal benchmark. The data and information collected thanks to this questionnaire will be utilised for the qualitative analysis of this thesis, aimed to identify how the regulatory role has evolved in European railways and where it will need to improve. Importantly, this analysis will update previous studies on regulatory activity, by covering the period after the 2012 Recast[17]. The

[17] The necessity of collecting empirical evidence on the impacts of the reforms is pointed out by Laurino et al. (2015), who develop a desk survey to review railway models at a global level, involving some of the European countries examined in this survey. The analysis of the role played by regulatory bodies carried out in this thesis is more in-depth though, and importantly grounded in first-hand evidence.

questionnaire design and progress will be illustrated in the next Chapter, while the results will be presented and discussed in Chapter 5. This bottom-up approach will complement the top-down approach which econometrically investigates the regulatory effects on railway efficiency. The qualitative and quantitative results in these ways obtained will ultimately both inform the policy implications of this thesis.

Chapter 4
Methodology for qualitative analysis

4.1 Introduction

Building on the findings emerged from the literature on the ideal rail regulator characteristics in Chapter 3, this Chapter will present the methodological approach behind the qualitative analysis of the thesis. This type of analysis aims to document how European railway regulators perform against the aforementioned ideal characteristics, thereby moving from the theoretical platform to the real scenarios. Methodologically, the way this process is carried out revolves around the design of a purposely designed questionnaire, including enquiries specifically informed with the evidence on the ideal rail regulator characteristics.

The responses to this questionnaire, coming from various sources involved in the European railway systems, would potentially be able to identify which roles have been forged for and by rail regulators and to what extent these roles adhere to the operational principles outlined by the literature. Besides investigating the distance between real and ideal roles, the questionnaire findings will also be scrutinised in order to detect general patterns, if any, in European rail regulation and ultimately answer these kinds of questions: Are railway systems progressing in a similar fashion in terms of economic regulation? Which ideal requirements are more commonly met and which are instead more commonly unfulfilled by European rail regulators? Which regulatory best practices and deficiencies can be traced at European level?

This Chapter will give an account of the intermediate and methodological stage situated between the literature review and the analysis of the questionnaire results. Section 4.2 will illustrate the design of the questionnaire, as well as its individual questions, explaining their rationale and highlighting their linkages with the ideal rail regulator characteristics. The questionnaire versions, its instructions and the range of actors surveyed are described in Section 4.3. Section 4.4 will focus on the progress of the questionnaire, depicting its timeline from the designing stages to the collection of the responses. Lastly, Section 4.5 will account for the methodological limitations of this survey, as well as suggesting future corrective actions.

4.2 Design of the questionnaire

As explained above, there exists a strong relationship between the findings from the literature on the ideal rail regulator characteristics and the design of the questionnaire. This connection is primarily attested by the choices regarding the 8 key areas composing the survey, which are listed in column 1 of Table 4.1 together with the related purposes in column 2. Column 3 highlights which participants (regulators and/or regulatees[18]) were involved in relation to the 8 key areas. Each of these key areas focuses on specific ideal rail regulator characteristics, and includes questions formulated with a view to capture the relevant regulatory practices in the analysed countries. This Section will describe in detail each of these key areas and its component questions.

Table 4.1 Questionnaire on ideal rail regulator characteristics: key areas

Key area	Purpose	Addressed to
1. Positioning in the market	Historical evolution of the regulator and competition levels of passenger sub-markets	Regulators only
2. Stability and predictability	Legislative and operational independence from government and other bodies, while promoting conditions for long-term planning	Regulators only
3. Non-discrimination	Ensuring fair access for operators when accessing the infrastructure	Regulators and regulatees

[18] The sub-set of regulatees includes infrastructure managers and railway undertakings.

Key area	Purpose	Addressed to
4. Distinct responsibilities	Avoiding overlapping of roles and accountability between regulator and government (or other agencies)	Regulatees only
5. Human and financial resources	Appropriate means to meet regulatory objectives	Regulators only
6. Transparency	Ensuring the accountability of the regulator	Regulatees only
7. Pro-activity and effectiveness	Growing autonomous powers for investigations and interventions	Regulators and regulatees
8. System efficiency	Accessing and analysing data on infrastructure managers' quality and efficiency	Regulators and regulatees

Within the first key area, related to the regulator's position in the market, the first set of questions are designed to capture general information about the experience of the regulator in order to assess its commitment, which is argued to be one of the ideal characteristics. Focus is therefore placed on the historical background of the regulator, with queries concerning the longevity of the regulator and its major responsibilities' changes in recent years. Related responses would potentially account for the regulator's evolution, in terms of capability to adapt to new legislation and industrial conditions. The second set of questions instead investigate the context in which the regulators operate, rather than the possession of ideal characteristics. Domestic passenger markets are specifically scrutinised since, across Europe, these markets typically represent the least developed in terms of competition. Questions attempt to define the proportion of the network allocated through public service contracts (in percentage of passenger km), moving then to examine the allocative procedures for public service routes (direct awards or tenders) and the respective proportion as a percentage of passenger km. Non-public service (or commercial) routes are

subsequently analysed, by detecting whether competition is legally permitted and actually occurs. For these last questions, the surveyed actors are asked to exclude cases where international services compete with national services.

In relation to the second key area inspired by the ideal characteristics of stability and predictability, the questions specifically investigate the regulator (or regulatory board) terms of appointment and decision-making processes. In the first place, the presence of a regulatory board as opposed to an individual regulator is ascertained. Whether the appointment of the regulatory board (or individual regulator) is for a fixed term and renewable is determined by the subsequent questions. This group of enquiries is required to capture not only the level of collegiality of the regulatory body's top management, but also the conditions defining its time in power. For those cases wherein the regulatory board is present, further questions ask for the number of board members, and how many of these are employed full-time. The proportion of full-time members may be important to delineate the level of commitment and participation shown by the top management of the regulatory body. Moreover, the voting system implemented to take decisions is examined, in order to assess whether unanimity or a simple majority is necessary to reach decisions. Importantly, the related information may be crucial in terms of establishing the level of discussion and depth behind the formalisation of regulatory measures. The relationship between the regulatory body and the government is investigated thanks to the final questions of this key area: the identification of the body appointing the regulator (or regulatory board), as well as the level of dependence of regulatory decisions upon governmental desiderata, may help to understand how free of interferences the regulatory domain is.

Non-discrimination (area 3) represents a broad key area of regulatory activity. Here the questionnaire explores the existence and extent of discriminatory situations connected with several railway aspects (such as track, rolling stock, highly specialised staff). The capability of the regulator to respond to these problems is assessed, as well as the number of complaints received and dealt with (on average in a one-year period). In addition, the presence of priority regulation is detected, in relation to cases of disruptions affecting train paths, access to services and timetabling process. A further section includes the analysis of framework agreements, attempting to establish both their proportion in respect to total capacity and which operators are involved. Understanding how extensive framework

agreements are may be relevant especially for those railway systems wherein infrastructure managers can prioritise the use of such device when deciding upon the allocation of capacity. In line with this, the overall intention behind the questions in this key area is to search for potential discriminatory practices and threats, and check the regulatory ability to tackle them.

The fourth key area pertains to the distinction of responsibilities between the regulator and the government (or other agencies): here are placed questions on the existence of connections between railway undertakings and the body (or bodies) issuing licences, safety certificates and vehicles certificates, and on the degree of independence of the regulator from political influence in respect of these matters. These enquiries are aimed to clarify the role of the regulator in its interrelating actions, especially whether these are informed with the necessary independence and accountability.

The adequacy of available human and financial resources is explored in the fifth key area, where queries intend to assess the number and backgrounds of the staff employed by the regulatory body and to detect which actors contribute to funding the regulatory activities. It should here be pointed out that the enquiries about the regulatory staff are only concerned with those employees working on economic regulation (and not, for instance, on safety and interoperability). The financial conditions are explored by identifying the funding actors, to which extent they contribute and whether they are represented in the regulatory board. Relevantly, the questionnaire also asks whether these financial contributions are deemed sufficient. Collecting this quantitative and qualitative information about the regulatory resources is considered as fundamental for the purpose of testing the autonomy of a particular regulatory body.

The sixth key area on transparency controls for the degree of openness established by the regulator and consists of questions on the clear and public specification of regulatory decisions and processes. These involve diverse aspects, including the regulator’s competence and powers, the issuing of licences, safety certificates and homologation of vehicles, and the allocation of capacity (together with the related conflicts resolution). Most of these are investigated under three profiles: whether their characteristics or procedures are publicly available and clearly specified, where this information can be traced, and whether there exist aspects that need to be clarified.

Within the seventh key area on pro-activity and effectiveness, the regulatory powers on the approval of track access charging schemes are examined.

Naturally, these represent one of the most significant factors in terms of supporting, or limiting, competition forces. Therefore, regulatory intervention on augmenting or consolidating the fairness of access charges ought to be taken into account. Further queries concern the legal and financial effects of the regulatory decisions, determining whether these are binding, and can be appealed against, and whether regulators are able to impose penalties. Regulatory powers are here scrutinised in terms of their extent and magnitude, determining the strength of the regulatory action once the decisions are formalised.

The last key area (area 8) refers to important powers conferred on regulators by the Recast, especially in relation to the identification of which regulatory mechanisms are in place to incentivise efficiency. This investigation is clearly of great interest for the aim of this thesis. The role played by regulators in regulating the infrastructure manager's performance and efficiency is examined, as opposed to the role played by the government through the multi-annual contract, the presence of which is also verified. Further questions attempt to define whether and how regulators monitor and enforce the quality and efficiency of the infrastructure managers' performance, as well as whether data on cost-efficiency and quality of service can be accessed. This range of questions helps shed light on how regulatory actions impact on efficiency and ultimately evaluating the success of reforms affecting economic regulation in rail. The related results will be useful not only for the qualitative analysis contained in Chapter 5, but also for drawing connections with the econometric estimates presented in Chapter 7.

4.3 Questionnaire versions, instructions and participants

Given the depth and diversity of the enquiries, the questionnaire is designed to involve crucial actors in the European railway industry. As seen in the previous Section, the questions cover not only regulatory aspects, but more economic and operational ones as well. For these reasons, the questionnaire was sent to regulators, infrastructure managers and railway undertakings.

Two versions of the questionnaire were designed for the parties involved: one for the regulators, and one for the regulatees, namely the infrastructure managers and the railway undertakings. These versions differ in terms of the individual questions (or whole key areas) selected, whose exclusion or inclusion seeks to avoid uninformed answers and to prevent potentially

biased responses. Blank copies of the two questionnaire versions are presented in Appendices B and C.

The difference between the two versions, and the rationale behind this designing choice, can be observed in some examples. The questions on regulatory board's term of appointment and structure were only addressed to regulators, as infrastructure managers may not be able to possess the relevant information on those points. Biased responses could emerge in relation to the independence of political influence or transparency-related queries: it appears intuitive that regulators may overestimate the level of independence of political influence or transparency of their processes and decisions, while infrastructure managers and railway undertakings, which are in the set of potential regulatees, may provide more realistic answers. This dichotomous structure is argued to appropriately capture the quality and effectiveness of regulatory practices in a railway system, by involving counterparties which interact with conflicting interests and thereby are able to offer objective information.

Instructions were provided together with the questionnaire. The overall aim of the questionnaire was presented in the front page, whereas each key area was introduced by a brief statement defining the purpose of the questions therein contained. Both open and multiple choice questions were formulated, with the possibility of expressing comments as well, both at the end of each key area and at the end of the questionnaire. It was also specified that the questions only refer to railway regulators and railway themes and should have been answered accordingly. Answers which are not specifically rail-related could have been given when it was not possible to distinguish between the characteristics and activities of the rail regulatory bodies (or divisions) and those of different agencies (or divisions) - for instance, when an authority for multiple transport modes is in place -, but this issue should have been pointed out. Some of the questions were pre-answered and only needed to be verified by the participants. These questions concerned information that is publicly available in industry reports and studies.

Moving to the list of participants involved, most of the contacts were obtained from the Community of European Railway and Infrastructure Companies (CER) Economics Group and the Independent Regulators' Group – Rail (IRG) Charges Working Group; more details on the collection of the responses are provided in the next Section. The initial objective was represented by approaching representatives from those countries included in the econometric analysis, in order to compose analogous samples. Due to

understandable difficulties, the involvement of all those selected countries was not possible. Nonetheless, responses from other countries were also collected, rendering the surveying project a rich and accomplished piece of the overall research. In the end, 17 regulators were contacted obtaining 14 responses, which correspond to a highly satisfactory 82% response rate. The focus is mostly placed on the regulators' responses as the participation of infrastructure managers and railway undertakings was limited, with the latter confined to incumbents rather than new entrants[19]. The full list of regulators who provided their responses is displayed in Table 4.2. The activities carried out to involve these actors and collect their responses are presented in the next Section.

Table 4.2 Questionnaire on ideal rail regulator characteristics: list of participating regulators

Country	Regulatory body
Belgium	Dienst Regulering van het Spoorwegvervoer en van de Exploitatie van de Luchthaven Brussel-Nationaal / Service de Régulation du Transport Ferroviaire et de l'Exploitation de l'Aéroport de Bruxelles
Finland	Liikenteen Turvallisuusvirasto / Finnish Transport Safety Agency (TRAFI)
France	Autorité de Régulation des Activités Ferroviaires et Routières (ARAFER)
Germany	Bundesnetzagentur / Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway
Greece	Regulatory Authority for Railways (RAS)

[19] The following 6 infrastructure managers and railway undertakings responded to the questionnaire (out of 19 potential participants contacted): ÖBB-Holding AG from Austria; NMBS / SNCB from Belgium; VR-Group Ltd from Finland; Ferrovie dello Stato Italiane S.p.A. from Italy; Polish State Railways – PKP from Poland; and SBB AG from Switzerland.

Country	Regulatory body
Italy	Autorità di Regolazione dei Trasporti (ART) / Transport Regulation Authority
Luxembourg	Institut Luxembourgeois de Régulation (ILR)
Netherlands	Autoriteit Consument & Markt (ACM) / Authority for Consumers & Markets
Norway	Statens Jernbanetilsyn (SJT) / Norwegian Railway Authority
Poland	Urząd Transportu Kolejowego (UTK) / Office for Rail Transport
Slovenia	Agencija za komunikacijska omrežja in storitve Republike Slovenije (AKOS) / Agency for Communication Networks and Services of the Republic of Slovenia
Sweden	Transportstyrelsen / Swedish Transport Agency
Switzerland	Railways Arbitration Commission (RACO) / Schiedskommission im Eisenbahnver (SKE)
United Kingdom	Office of Rail and Road (ORR)

4.4 Questionnaire timeline

The design of the questionnaire, its diffusion and the collection of the related responses occupied a long period of time within the overall research. Once the first design of the questionnaire was prepared, a pilot was attempted by asking a representative of the Swedish regulatory body to respond and comment on the questions. Unfortunately, this piloting activity did not take place and, in the face of the project's decreasing temporal limits, was replaced with an alternative option. This envisaged the start of the actual survey, while allowing for the refinement of the questionnaire on the basis of the comments received by the first respondents. Thanks to personal contacts and the ones made available at an international conference, a handful of regulators were approached, receiving responses from the British, French and German representatives. As explained, this alternative option

was not only important for the collection of the first responses, but also for the regulators' comments, particularly useful to understand which questions needed to be re-designed or removed completely, and which instead deserved to be incorporated. Naturally, these alterations involved both versions of the questionnaire, in relation to those cases when the same questions or key areas were affected.

A significant breakthrough was realised when a presentation was organised at one of the meetings held by the CER Economics Group. The questionnaire had been sent prior to the meeting by the Group Chair to the members, together with a brief introductory document. The participation in this event, especially thanks to the discussion that followed the presentation of the project, greatly contributed to expedite the collection of the responses, sent by 6 infrastructure managers and railway undertakings present at that meeting. Reminders were also sent by the Economics Group Chair in the following months to stimulate the widest possible participation.

The majority of regulators' responses were obtained thanks to the participation in a similar event, organised by the IRG Charges Working Group. Also in this case, copies of the questionnaire and the project introduction had been distributed to the members by the Group Chair before the meeting. In that context, the revised version of the questionnaire was presented not only to new respondents, but also to old ones (as mentioned previously, from United Kingdom, Germany and France) to whom it was asked to only answer newly introduced questions. The German and the French representatives provided these extra responses on their railway systems; in the French case, this took the form of a telephonic interview, thanks to which a revision of old responses was also carried out. Unfortunately, the same revising activity was not possible with the British regulator. However, since the differences in the original and final versions are small, the answers from the British regulator were included in the analysis. Minor changes, arising from the feedback on the presentation of the project, altered the final version of the questionnaire, which the Group Chair again distributed between the Group members following the meeting. The success of the participation in the IRG meeting is demonstrated by the particularly high number of respondents in its aftermath: excluding previous (and revising) respondents, 10 regulators sent back their completed questionnaires, including some members which had not attended the meeting, but whose contact details were made available by the Group Chair.

In addition to this, a different representative of the Swedish regulatory body was contacted and the related responses collected. This was seen as particularly necessary for the research, since Sweden represents one of the most advanced contexts in rail regulation and competition around Europe.

Finally, the questionnaire was first sent out in October 2014 and all responses were received by August 2015.

4.5 Methodological limitations

This final section intends to discuss the methodological difficulties emerged from the construction and actual development of this surveying project, mainly focusing on the selection of the key areas of the questionnaire and the choice of actors involved.

While the detection of relevant key areas represents a noticeable breakthrough for the literature, the related set cannot be considered complete. Further key areas may emerge in future, not only from railway-related studies but also from evidence based on comparable network industries. Possibly, these new key areas may be able to enrich the design of future surveys, by delving even more into the role played by regulators in railways.

This difficulty leads to a connected one: the formulation of the questions has not indeed been uniformly smooth. The ambiguous nature of certain questions has determined the adoption of a surrogate strategy aimed to stimulate answers as accurate as possible. This is traceable when observing the enquiries on the regulators' independence and autonomy, which have been accompanied by ancillary questions potentially able to ascertain the extent of these ideal characteristics not only on paper but also in action. For instance, regulatory independence and autonomy have been scrutinised by requiring information, respectively, on the procedure for the appointment of the regulatory board members, and on the amount of financial and human resources available. Albeit to a limited extent, this strategy might have neutralised biased responses, which represented one of the problems predicted during the planning stages of this survey.

The risk of receiving biased answers is clearly triggered by the type of actors involved. Restrictions such as lack of available contacts and temporal limitations have prevented from relying on a larger and more diverse set of addressees. This is particularly evident for the group of infrastructure managers and railway undertakings which, for instance, ought to be

enriched with non-incumbent operators. The views expressed by this type of actors may differ from and contrast the mainstream which, especially for discriminatory practices and regulatory promptness, does not questionably highlight any relevant problem (as it will be seen in the next Chapter).

Moreover, the role played by regulators within the overall railways governance should be assessed examining the governmental positions. In this area, governments still seem to hold relevant decisional power in many countries, even when the independence and autonomy of the regulators is guaranteed by law. Involving governments in future surveys may represent the opportunity to assess how actually free of interferences the regulatory actions are.

Overall, the involvement of the current actors is of great support for the qualitative analysis of this thesis. Understandably, an even wider participation, especially on the part of infrastructure managers and railway undertakings, but also by extending the survey to governments, appears desirable. While these expansions are possible for future research, it should nonetheless be pointed out that this represents one of the first surveys capable of delving into the regulatory scenarios in European railways on such a scale, importantly providing with much needed first-hand evidence on this field.

Lastly, a note on the methodological approach needs to be indicated. All the actors approached were assured that the information provided was to be maintained confidential. Given this condition, the analysis of the responses, extensively presented in the next Chapter, will not be aimed to single out individual countries, but to identify general Europe-wide trends from an aggregate examination of the findings.

Chapter 5
Questionnaire results

5.1 Introduction

Following on the design of the questionnaire on rail regulation and the collection of the related responses, this Chapter will focus on describing and commenting on the findings obtained. In particular, this analysis will look at the extent to which European rail regulators have conformed their structure, operations and powers not only to current legislation, but also to those ideal rail regulator characteristics which informed the choice on the questionnaire key areas. Bearing in mind the confidentiality limitations explained in the last Chapter, the responses will be observed in a collective way, rather than isolating a particular system's practices. Consequently, the intention of this Chapter is to detect regulatory patterns across Europe, if any, and to identify those areas where the regulatory performances need consolidation or improvements. In terms of the overall research, this qualitative analysis conducted in respect to the questionnaire responses will constitute the basis for formulating policy implications and recommendations on the rail regulators' role, complementing the quantitative analysis on the effects of the reforms on economic regulation which will be presented in Chapter 7. These policy considerations will find large space in the concluding Chapter 8.

This Chapter will report and discuss the questionnaire results in Section 5.2, which is sub-divided according to the questionnaire key areas. Section 5.3 will then draw conclusions on the overall surveying project.

5.2 Questionnaire results and discussion

The results will be illustrated and discussed following the categorisation in key areas presented in Chapter 4, by specifying from which source the information derives: either from regulators or from infrastructure managers and railway undertakings. A summary of results from selected questions is provided in two separate tables: Table 5.1 for the regulators and Table 5.2 for the infrastructure managers and railway undertakings. As noted earlier, the participation of infrastructure managers and railway undertakings was particularly limited. In addition, the responses received from these actors tend to confirm the responses of the regulators. Therefore, regulators' responses will be predominantly illustrated, except for a few cases (for instance, key area on transparency).

Table 5.1 Questionnaire on ideal rail regulator characteristics: summary of selected responses from regulators (covering areas 1-3, 5, 7 and 8).

Key area	Issue	Sample	Yes	No	Don't know	Detailed response
1. Positioning in the market	Experience of regulator	14				More than 5 years (11); Less than 5 years (3)
	Procedures for allocation of routes under public service contracts	14			4	100% direct awards (6); Direct awards and tendering (2); 100% tendering (2)
	Actual passenger competition in routes not covered by public service contracts	14	5	3	2	Not legally permitted (4)

Key area	Issue	Sample	Yes	No	Don't know	Detailed response
2. Stability and predictability	Individual regulator or regulatory board	14				Individual regulator (7); Regulatory board (7)
	Fixed-term appointment of regulator	14	11	3		
	Majority voting for regulatory board's decisions	14	5		2	Individual regulator decides (7)
	Appointment of individual regulator or members of regulatory board	14			2	By the government (10); Others (2)
	Governmental guidance on regulatory decisions	14	1	11	2	

Key area	Issue	Sample	Yes	No	Don't know	Detailed response
3. Non-discrimination	Complaints received by the regulator (on average in a one-year period)	14			3	Less than 5 complaints per year (8); More than 5 complaints per year (3)
	Favouring certain RUs when disruptions occur	14	4	9	1	
5. Human and financial resources	Number of employees	14			1	More than 10 (4); Less than 10 (9)
	Adequacy of financial resources	14	10	3	1	
7. Pro-activity and effectiveness	Approval of all track access charging schemes	14	5	8	1	

Key area	Issue	Sample	Yes	No	Don't know	Detailed response
	Legally binding decisions by regulator	14	14			
	Regulator's possibility of imposing penalties	14	11	3		
8. System efficiency	Regulator's role in monitoring and enforcing the quality and efficiency of the infrastructure manager	14	4	9	1	
	Regulator's possibility of requiring data on cost-efficiency and quality of service from the infrastructure manager	14	4	7	1	Individual cases (2)

Key area	Issue	Sample	Yes	No	Don't know	Detailed response
	Body regulating the performance and efficiency of the infrastructure manager	14			4	Regulator (1); Regulator and government (1); Government (7); Safety authority (1)

Table 5.2 Questionnaire on ideal rail regulator characteristics: summary of selected responses from infrastructure managers and railway undertakings (covering areas 3, 4 and 6)

Key area	Issue	Sample	Yes	No	Don't know	NA
3. Non-discrimination	Presence of discriminatory practices	6		6		
	Promptness of regulator's intervention in case of discrimination	6	4		1	1

Key area	Issue	Sample	Yes	No	Don't know	NA
4. Distinct responsibilities	Collusion between RUs and regulatory bodies	6		5		1
	Regulator's independence	6	5		1	
6. Transparency	Transparency of regulatory roles, objectives, powers and processes	6	6			
	Existence of regulator's annual report	6	2	2	1	1
	Transparency of decisional methods and process involving licensing, safety certificates and homologation of vehicles	6	5			1
	Transparency of allocation processes and decisions	6	5			1

5.2.1 Positioning in the market

The positioning in the market (area 1) defines the experience of the regulator and the major changes undertaken in recent years. The majority of regulators have accumulated an extended operational longevity, at times over 15 years. In particular, 11 regulators out of 14 have more than 5 years of experience, indicating that these bodies seem to have reached a stable position in the industry which, on paper, may have contributed to provide them with an appropriate level of credibility and commitment. This is also identifiable by looking at recent changes at national level to regulatory responsibilities, on the basis of the responses received from 11 regulators (out of 14). These changes not only conferred greater independence on the regulators, but also increased their weight and participation in key processes, such as the monitoring of the multi-annual contracts attributed to some of them. Importantly, these alterations are all directed towards an expansion of the powers of the regulators, rather than restricting their remit.

In terms of the configuration of the passenger market, the related results do not seem to be particularly encouraging from the point of view of competition. The proportion of the passenger market covered by public service routes (in passenger km) is on average equal to approximately 77%[20], and direct awards represent the predominant method of allocation: regulators' responses (from 14 countries) indicate that in 6 countries direct awards are the only procedure utilised, while in another 2 countries the related implementation is alternate with tendering procedures, which only play a marginal role though. Only in 2 countries in the sample is competitive tendering the norm[21]. Also, regulators only rarely play a role in the designing stages of the tendering procedures. Overall, utilising direct awards is argued to restrict the level of contestability, by limiting the number of competitors for specific public service routes, which instead may be more efficiently allocated by tendering procedures. Nevertheless, the choice of formalising a direct award may be due, among other reasons, to

[20] This question was pre-answered by using 2012 data and, in some cases, was corrected by the regulators with more recent information. The differences are not large, confirming a constant trend in this area.

[21] Numerically, approximately 87% of the routes under public service contracts is allocated, on average, through direct awards (in passenger km). It should be noted that this figure refers to only 10 systems, as 4 regulators did not provide any answer.

the lack of newcomers able to rival the incumbent, which is the case for several domestic markets.

A further question addressed to regulators concerns the existence of open access conditions for non-public service routes in the domestic passenger market, excluding cases where international services compete with domestic services. While open access is legally permitted in 8 countries (out of 14), in only 5 of them does this actually occur, possibly attesting that lack of competitors previously mentioned.

5.2.2 Stability and predictability

The second key area on stability and predictability determines how the regulators function in terms of appointment, structure and decision-making. The regulators' sample (amounting to 14 participants) is equally divided in relation to the presence of either an individual regulator (7 countries) or a regulatory board (remaining 7 countries). The stability of the appointment is guaranteed in 11 countries (fixed-term contract), with an average duration per term equal to approximately 5.45 years. In reality the overall appointment may last longer, as these positions are renewable once in 6 countries, and more than once in 3 countries. These results seem to go in the direction of avoiding frequent planning modifications on the part of regulators, who have the possibility of setting their activities with a long-run perspective. Though the picture therefore seems positive here, it should be noted that the possibility of re-appointment (2 regulators even indicated that no limit exists in the possibility of re-appointment) may determine a prolonged, and potentially detrimental, situation where regulatory power remains in the same hands for many years.

In the sample, the majority of the components of the board are employed full-time[22], indicating another sign strengthening the perception of the regulatory commitment by other industry actors; in particular, the boards, on average, consist of 4.50 members. Decisions, apart from the 7 cases where an individual regulator is present, are taken by majority voting in 5 countries[23]. The procedure for the board's appointment is equivalent for most regulators, with the government selecting board members in 10 countries (out of 14). In 2 countries, the appointment is determined by the

[22] In total, about 73% of the members in regulatory boards are employed full-time. In 3 countries, the regulatory board does not exist, while 1 regulator did not provide any answer.

[23] This information was not available for 2 countries in which a regulatory board is present.

parliamentary president on the one hand, and by the board of the regulator itself on the other. These questions lead to the examination of how the regulator and the government interact. Only 1 regulator included in the sample, when taking decisions, seems to have the obligation to take into account governmental guidance: also, from the answers received, governmental instructions appear to be either rare or not binding. Naturally, this detachment from political aims represents an important requirement for the regulatory autonomy that, according to these results, has reached a widespread application across Europe.

5.2.3 Non-discrimination

The activities substantiating independence are explored further by looking at the answers on non-discrimination issues (area 3), which involved all the participants (regulators and regulatees) to different extents. Within this area, infrastructure managers and railway companies only were queried with regards to a sub-set of questions on the presence of discriminatory practices and regulatory promptness upon tackling such problems. Regulators only were instead questioned on another sub-set of enquiries, pertaining to the number of complaints received, and whether certain railway undertakings are favoured when disruptions occur. Finally, all the participants were asked about the existence and extent of implementation of framework agreements. Perhaps surprisingly, infrastructure managers and railway undertakings did not detect any discriminatory problem connected to a wide range of railway areas[24]. It should be noted however that the railway undertakings surveyed are incumbents, and potentially suffer to a smaller extent from these problems as opposed to newcomers. Also, regulators' promptness on tackling related problems is considered satisfactory by 4 participants (out of 6)[25]. In reality, this promptness has been tested in a very small number of cases in several countries: indeed 8 regulators (out of 14) receive less than 5 complaints per year (on average), and 3 of them have indicated that no complaint was ever lodged. Nonetheless these responses, by offering a valuable snapshot of the

[24] The question focused on the following areas where discrimination may occur: track, rolling stock, highly specialised staff, use of electrical supply equipment for traction current, refuelling facilities, freight terminals, marshalling yards, train formation facilities, storage sidings, depots, passenger stations, or any additional area.

[25] In relation to the 2 remaining countries, in one case problems concerning the timeline of the regulatory processes were highlighted, while in the other case no information was available.

current role played by regulators in railways, allow to appreciate the wider range of powers and activities these bodies now enjoy, if compared with the limiting conditions observed at the outset of this reforming season.

As mentioned previously, area 3 covers further questions on potential discriminatory issues arising from disruptions or when framework agreements are stipulated. The minimisation of discriminatory practices seems to emerge also when the regulators are asked about the presence of railway undertakings somehow favoured in case of disruptions: only 4 regulators (out of 14) indicate this to happen, determining a priority treatment especially for passenger transport. Lastly, as documented by the responses collected from both regulators and regulatees, framework agreements between the infrastructure managers and the railway undertakings are characterised by moderate diffusion across Europe: in most of the considered countries a threshold has been determined, but only in 4 countries (out of 15, the whole sample of countries involved in the questionnaire[26]) do framework agreements actually cover more than 10% of the overall capacity. Given the possibility for infrastructure managers to assign priority to framework agreements when deciding on the allocation of capacity, these results seem to attest that potentially discriminatory practices in this field are rather infrequent.

In general, discrimination does not seem to be considered a problem by the infrastructure managers and railway undertakings in our sample, and regulators appear to play a proactive role when the need arises (in terms of responses to lodged complaints): determining whether regulatory actions or the contextual market characteristics primarily drive towards this configuration is not clear. It should be noted that the sample does not include new entrant railway undertakings who may have given different answers on this question.

5.2.4 Distinct responsibilities

The autonomy of the regulators is further verified by the responses related to the key area on the distinction of responsibilities (area 4), for which only infrastructure managers and railway undertakings were interrogated. In 5 countries (out of 6), collusive relationships between railway undertakings and bodies issuing licences, safety certificates and vehicles certifications

[26] 15 is the total number of countries analysed in our questionnaire, taking into account the country of origin of all the participants (regulators and regulatees).

were not found[27]. Importantly, a general awareness of the independence of the regulator appears to emerge: all 6 infrastructure managers and railway undertakings deny the governmental influence over regulatory decisions and are able to identify the source of the regulator's independence, typically determined by the legislation.

This outcome, together with what was found in the previous key area (area 3), seems to confirm that the actors ultimately impacted by the regulators' processes and decisions positively evaluate the regulatory *modus operandi*: in general, regulatory actions appear to be informed with autonomy and to be potentially able to tackle issues affecting their national markets.

5.2.5 Human and financial resources

Whether regulators are appropriately equipped to carry out these actions is scrutinised by the questions on human and financial resources (area 5). Currently, the responses to the questionnaire show that, in terms of full-time equivalent, 266.8 employees work across 13 countries[28] for the regulatory bodies on railway economic regulations only (excluding safety and interoperability). Comparing this result with the data provided in 2006 by IBM's report on rail regulation in Europe[29] (IBM Business Consulting Services, 2006), the number of staff employed has nearly doubled: in particular, 3 regulatory bodies which had no staff in 2006, have now employed personnel, even though only 4 regulators (out of 14) have more than 10 employees. The backgrounds of the personnel are rather diverse, mainly associated with economic and legal, but also involving rail industry, engineering and administrative expertise.

The capability of hiring new staff does, however, seem to be limited for 3 regulators (out of 14), where the amount of resources received is not considered adequate. These resources derive from two sources: funding is provided fully by the government for 8 regulators, fully by the industry for 5, and by both for the remaining 1. These financing bodies are represented in the regulatory board only in 1 country, thus almost all decisional processes

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[27] For the remaining country, the provided answer is inconclusive on this point.

[28] One regulator did not answer to this question.

[29] According to the IBM's report, the number of employees involved in rail regulation in 2006 was equal to 144 (in this sample). Nevertheless, only a part of this staff dealt with regulatory issues full-time, even though the exact proportion was not specified.

appear not to be influenced by the positions of the budget funders. In general, the majority of regulatory bodies have not indicated problems with the amount of human and financial resources available, and the growing trend in the number of staff seems to corroborate this. Nevertheless, the financial difficulties affecting 3 regulators are not to be underestimated, producing warnings especially for those contexts where the governmental funding may be restricted by fiscal constraints.

5.2.6 Transparency

The regulators' efforts on transparency (area 6) have reached appropriate levels, according to the responses given by infrastructure managers and railway undertakings. When asked about the transparency of the regulators' competence and processes, and the procedures for licensing, safety certificates, homologation of vehicles, and the allocation of capacity, the regulatees expressed positive views, also indicating the sources where the related explanatory documentation is available[30]. A negative area concerns the presence and monitoring of annual reports: the 6 responses from infrastructure managers and railway undertakings suggest that only 2 regulators produce such a report, which is checked by an impartial third party only in 1 country. In sum, this deficiency, albeit important, does not appear to considerably affect the accountability of the regulator, whose operations are characterised by adequate clarity and are publicly detailed.

5.2.7 Pro-activity and effectiveness

Moving to the seventh key area related to pro-activity and effectiveness, regulators' powers turn out to be rather limited in respect to a crucial element in the railway industry, namely track access charging schemes. Only 5 regulators (out of 14) have the possibility of approving the totality of these schemes, upon the related submission, even though the Recast indicates that the regulatory body shall ensure that charges set by infrastructure managers comply with the principles set out in the Recast. Responses from infrastructure managers and railway undertakings confirm the unbalanced trend characterising this task, for which regulators seem to play an active role only when connected complaints are raised and non-discrimination needs to be preserved (as previously highlighted): nonetheless this may be rare in those numerous contexts where competition is lacking. This function pertaining to the approval of all charging schemes is in need of uniformity across Europe: the lack of power

[30] Only one participant identified two areas that need better specification.

in this respect means that regulatory capabilities are not being fully exploited (as attested to some extent also by the results emerging in the previous key areas). On the other hand, a positive picture emerges regarding the enforcement powers accorded to regulatory decisions: all the regulators (14) are able to produce legally binding decisions[31], and the majority (11) can impose penalties, in most cases hitting a certain proportion of the sanctioned company's turnover.

5.2.8 System efficiency

A similarly unbalanced trend is identified in the last key area (area 8), where the monitoring powers of the regulators are investigated, with particular reference to the activity of the infrastructure managers. The position is here, perhaps, unexpected, considering the new powers given by the Recast in this area. Only 4 regulators (out of 14) play a role in monitoring the performance (quality of the infrastructure) and efficiency of the infrastructure managers, while 3 of these and 1 other can require data to support their regulatory role[32]. This is corroborated by the presence of only 2 countries in which the regulators (alone or with the government) regulate the performance and the efficiency of the infrastructure manager (that is, more than simply a monitoring role), as opposed to the alternative situation (7 countries) where exclusively the government plays this role through a multi-annual contract, which exists in 11 countries (out of 15, the whole sample).

Clearly several regulators across Europe partially fail to positively impact on their railway systems' costs and quality, as confirmed by similar results emerging from the responses sent by infrastructure managers and railway undertakings[33]. While diverse activities are in place in a number of countries - covering tasks such as audits, investigations, notification of warnings and, in some cases, even the possibility of affecting infrastructure managers' powers -, these are argued not to embrace the full range of

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[31] The possibility of appealing against decisions is allowed in 12 countries (out of 14).

[32] It should be noted that another 2 regulators can access this type of data, but only for individual cases and not as a general practice.

[33] In this sub-set of our sample, only 2 out of 6 participants detect the possibility for the regulator of demanding data on the infrastructure managers' cost-efficiency and quality.

possibilities conferred on regulators by the relevant legislation. Influencing the efficiency and quality of infrastructure managers' performance ultimately produces potential repercussions on costs, access charges, competition and demand levels, and this seems to be mainly achieved thanks to the enforcement of multi-annual contracts (by governments) around Europe. This scenario, together with the drawbacks identified previously in respect to the track access charging schemes, appears to negatively impact on the regulators' capability to play a substantial role in the safeguard of their railway markets (though of course the Recast does permit the government, rather than the regulator, to take on the role of regulating quality and efficiency).

5.3 Conclusions

This Chapter investigated the responses provided to the questionnaire on ideal rail regulator characteristics. These were collected from a sample of European regulators, infrastructure managers and railway undertakings in order to verify how the regulatory structures of European railways conform to this ideal benchmark. The results can be summarised as follows:

- Most of regulators appear to have accumulated adequate experience in the railway systems wherein they operate, and recent changes show their capability to adapt to new legislative and market conditions;
- Appropriate levels of independence of political influence and autonomy, in terms of structure, decisional making and resources available, seem to have been achieved by the majority of railway regulators;
- Similarly, transparency and accountability requirements are argued to be satisfactory by the set of regulatees;
- Positive outcomes also seem to emerge with regards both to the powers inherent in regulatory decisions, normally legally binding and capable of imposing penalties;
- Limits arise when looking at regulatory powers on monitoring the efficiency and quality of the railway systems, particularly in relation to the approval of access charges and control of infrastructure managers' performances;

- Regulators' role in promoting competition levels is generally restricted to the preservation of non-discrimination, while little is their involvement in designing tenders, which nevertheless are infrequently utilised to allocate public service routes around Europe.

Therefore, a number of formal requirements appear to have been met, but more substantial powers are modestly diffused across European regulatory structures. These qualitative results will contribute to the discussion on policy implications on the regulators' role in the conclusive Chapter 8, in combination with the quantitative findings on the impacts of economic regulation on railway efficiency. The methodological approach of this quantitative analysis will be presented in the next Chapter.

Chapter 6
Methodology for quantitative analysis

6.1 Introduction

The questionnaire results reported in the previous Chapter define and inform the qualitative side of this research. By focusing on current regulatory trends, divergences, best practices and deficiencies characterising European railways, the questionnaire contributes to give account of the role played by regulators, investigating the nature and extent of their operations and interactions with other railway actors. In this and the following chapter, the research moves a step forward and attempts to establish the type and size of the effects, if any, produced by regulators, and economic regulation in general, on European railways systems. The regulatory effects will be analysed by specifically looking at the results on railway efficiency. The rationale behind this choice is justified by the European Commission original intention to promote and allow railways to become the main mode of medium distance routes in the passenger market and long distance routes in the freight market. The achievement of this objective required considerable improvements in efficiency obtainable, in the eyes of the European legislators, through stronger levels of intra-modal competition, onto which the range of reforms has attempted to impact. In this sense, this research complements the prolific and varied literature on the impacts of railway reforms, by shedding light on a somewhat unexplored area: the effects on efficiency produced by the reforms affecting economic regulation and the role played by regulators.

This chapter will illustrate the methodological connotations of the analysis on the regulatory impacts on efficiency. This analysis, in line with the contributions belonging to the previously mentioned literature strand (and detailed in Chapter 2), will be quantitative and centred on econometric estimates. The presentation of the related data and the variables used in the econometric model will be explained in the next Sections. The next Section (6.2) will cover the construction of the regulation index (6.2.1) as central to the study's objectives, highlighting its methodological limitations (6.2.2) as well. In Section 6.3, the emphasis will shift onto the overall presentation of the econometric model, together with the indications on the data sources. More specific description of the remaining variables and

notes on the estimation method are included in Section 6.4. Lastly, Section 6.5, by providing the economic rationale behind the model choice, delineates the a priori expectations on the policy variables' behaviour.

6.2 Regulation index characteristics

This section will focus on one of the major cornerstones, and at the same time novelties, of this research, namely the use of a regulation index for Europe's railways. The details behind its construction will be illustrated in Section 6.2.1, while Section 6.2.2 will discuss the related methodological limitations.

6.2.1 Constructing the regulation index

Building a regulation index naturally arises from the intention to study the regulatory structures in the European rail industry, with a view to detect their effects on railway costs and efficiency. As previously discussed in Chapter 3, regulatory bodies may influence costs and efficiency by a number of means, both directly through pressure on infrastructure managers, and indirectly through promoting competition.

The IBM and Kirchner studies (2002, 2004, 2007 and 2011) provide an overview on the state of the liberalisation processes in the European Union countries, formulating rankings in order to evaluate which countries are denoted by advanced, scheduled and delayed progress. The evidence is summarised by calculating the scores (from a minimum of 1 to a maximum of 10) for specific subject macro-areas for each country which, in turn, correspond to the sum of drivers and sub-drivers inherent in various aspects, broadly clustered into: the legislative transposition of the European directives and regulations; the effective implementation of these policies; and the competitive characteristics of the markets. A list of the sub-drivers selected for the regulation index is presented in Table 6.1.

The major interest of this thesis is addressed towards the consideration of those sub-drivers that appropriately describe the regulatory systems, covering:

- The general aspects of the authority (including elements such as independence, accountability and transparency);
- The object of the regulation (for instance, the responsibilities deriving from different types of inspections);

- And its powers (involving the possibility of imposing coercive means, or the nature of the investigations that are allowed to be performed)[34].

Table 6.1 Regulation index: drivers and weights

Source: IBM and Kirchner (2002, 2004, 2007 and 2011). Weights have been re-calculated by the author to reflect the specific set of sub-drivers selected for the regulation index.

Macro-area	Driver	Sub-driver	Weight
Competence of the regulation authority	General aspects of the regulatory authority	Existence of the regulatory authority pursuant to Art. 30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017
		Transparency of competence of regulatory authority	0.017
		Transparency in case of proceedings/sanctions	0.017
		Independence of political influence	0.017
		Existence of an annual report	0.017
	Object of the regulation	Inspection of network statement (10 aspects)	0.022
		Investigations concerning allocation procedure	0.022

[34] Laabsch and Sanner (2012) utilise the IBM Rail Liberalisation Index in their study on the impact of vertical separation on the success of railways, but their method and purpose are different from what is pursued by this thesis. The above authors include the totality of drivers in order to account for the degree of market opening in the different countries, and only consider the last 2 reports (2007 and 2011). The intensity of regulation is instead measured in a rather limited way, by using the number of staff of the regulatory body.

Macro-area	Driver	Sub-driver	Weight
		Investigations concerning charging scheme	0.022
		Investigations concerning level or structure of user fees	0.022
		Monitoring competition	0.022
	Powers of the regulatory authority	Can/must start investigations upon request	0.015
		Can/Must start investigations ex officio	0.015
		Legally binding character of regulatory authority decisions	0.029
		Determination by the regulatory body	0.015
		Possibility of imposing coercive means	0.015
		Possibility of imposing fines	0.015
		Possibility of issuing ex-post and/or ex-ante decisions	0.015
		Legal certainty of ex-ante decisions	0.015
		Monitoring processes	0.015
Administrative barriers	Licensing	Independence of decision maker from incumbent	0.034
		Transparency of licensing process	0.017
	Safety certificate	Independence of decision maker from incumbent	0.012

Macro-area	Driver	Sub-driver	Weight
		Transparency of issue process	0.012
	Homologation of vehicles	Independence of decision maker from incumbent	0.059
		Transparency of issue process	0.059
Operational barriers	Train path access conditions	Existence of priority regulations for certain RUs	0.055
		Non-discriminatory access to services	0.055
		Non-discriminatory marketing for all train paths	0.041
		Transparent mechanism to resolve conflicts	0.028
		Framework contracts	0.028
		Transparent and standard train path allocation process	0.039
	Infrastructure charging system	Coverage of infrastructure charging system	0.110
		Publication of infrastructure charging system	0.055
		Uniform charging system	0.055
Total			1.000

To develop the analysis, from the IBM and Kirchner's list of sub-drivers those specifically related to regulation are extracted, and are then used to construct a new regulation index for each country and time period in the sample. This index is then incorporated into the econometric model in order

to permit more substantial analyses of the regulatory effects on railway costs than those elaborated by the existing railway-related literature.

Specifically, the index includes regulatory drivers and sub-drivers, and relative scores, for a group of 17 European countries. The versions of the reports were published at staggered intervals; hence the insertion of the quantitative information for the intervening years between reports is estimated automatically through an averaging approach, calculating the mean between the values connected to two consecutive reports. Where the numerical alterations are greater than a certain threshold (chosen to equal ± 3 points), appropriate legislative or operational details have been sought in order to determine the reasons underlying these changeovers. When a sub-driver is not present for a specific year, the constant scores assumption is instead employed, inserting the value connected to the temporally closest report, where that factor is examined. Bearing this in mind, the range of answers for the sub-drivers included in the regulation index is presented in Appendix D, as extrapolated from the 4 Rail Liberalisation Index reports. In relation to the weights, these are held constant for the entire temporal interval to the ones chosen by the authors in the most recent report. This choice reflects the presumption that, with time, the authors accumulated the necessary experience to design an increasingly accurate weighting system. Scores and weights were given in an arbitrary way by the reports' authors, but this issue is recognised to be natural in this type of study, for which a degree of subjectivity ought to be taken into account. The range of activities performed to construct the regulation index is summarised in Table 6.2.

Table 6.2 Activities performed to construct the regulation index

1	Collection of the Rail Liberalisation Index reports published in 2002, 2004, 2007 and 2011, in part available online, and in part obtained through direct request to Deutsche-Bahn (DB) staff
2	Selection of the relevant sub-drivers presented in the studies, for the purpose of identifying a range of typical regulatory issues
3	Conglomeration of the regulatory data of 17 European countries in a single panel

4	Calculation of the regulatory index for each report and each country (4 indices for 17 countries), making use of the weights chosen by the authors for the 2011 study, then re-calculated according to the chosen set of sub-drivers
5	Inclusion of additional data for the gap years (average and constant scores)
6	Identification of the reasons behind the main changeovers impacting the scores of specific sub-drivers over time

Given these notions on scores and weights, Figure 6.1 provides a visualisation of the trends characterising the railway systems in the sample in terms of their regulation index, displaying top, average and lower quartile lines. As attested by the approaching trends of the average and lower quartile lines towards the top line, the figure shows the improvements made in economic regulation throughout the interval for which regulation index data are available (2002-2011)[35]. A deeper study of the regulatory performances for individual railway systems is included in Appendix E, where scores for each sub-driver across the temporal interval 2002-2011 are presented.

[35] It should be noted that the cost data for 10 railway systems was only available up to 2007. Therefore, the regulation index data for these railway systems had to be dropped for the sub-period 2008-2010 in the econometric analysis. This implies that the extent of the improvement in economic regulation (as depicted by the growth in the average and lower quartile lines) is only partially accounted for in the econometric models.

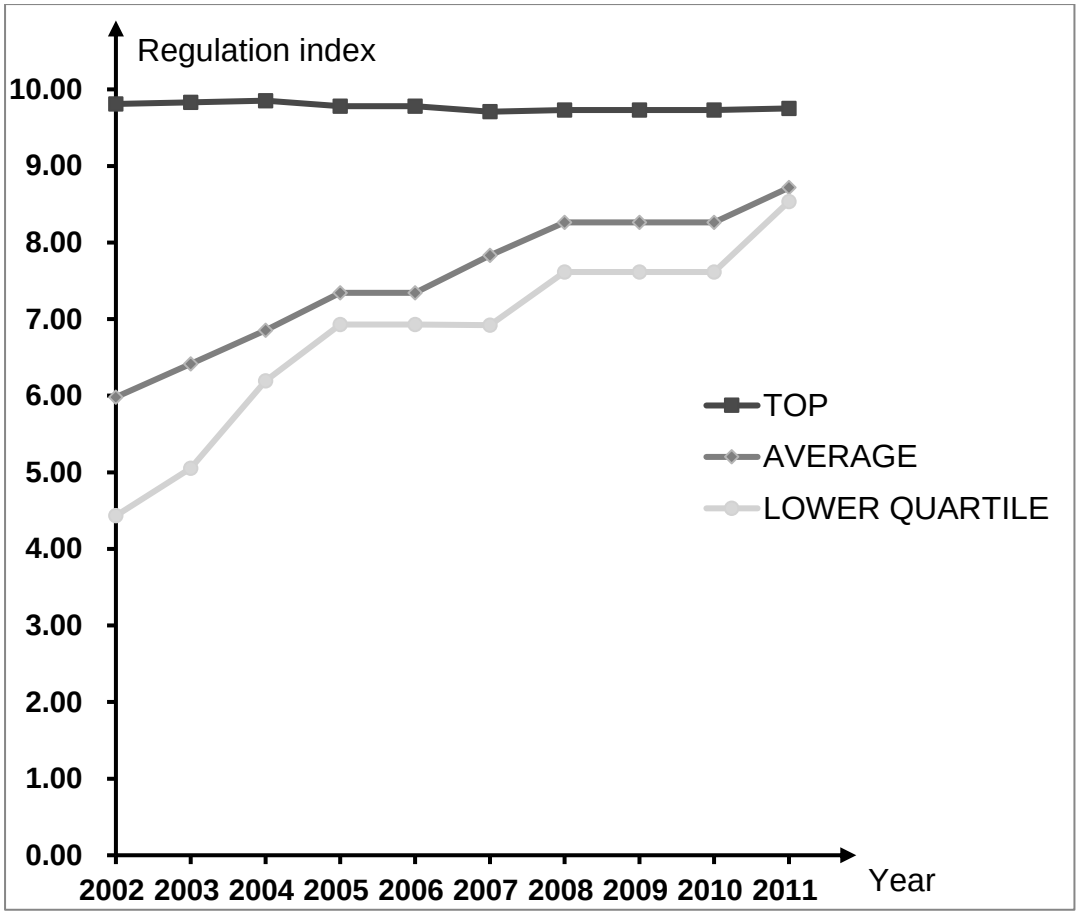

Figure 6.1 Regulation index trends for top, average and lower quartile in the sample (2002-2011)

Source: Author based on scores included in IBM and Kirchner (2002, 2004, 2007 and 2011).

6.2.2 Methodological limitations

As explained previously, the regulation index strongly builds on the IBM Rail Liberalisation Index Reports (IBM and Kirchner, 2002, 2004, 2007 and 2011), thus inheriting difficulties affecting those studies. Firstly, their irregular publication path does not allow access to a readily employable dataset. Filling the data for the gap years has implied using interpolative methods based on average and constant scores (as explained in the previous Section), forcing to rely on a second-best option. Naturally, the accuracy of this scoring system bears the effects of this methodological expedient, calling for in-depth documental reviews able to improve the temporal combination of the regulatory changeovers with the respective scores. This combining activity has been partially carried out during the research by looking at relevant references, and may represent a strand to further pursue in future.

Secondly, the sets of macro-areas, drivers and sub-drivers (detected in the designing process of the regulation index) require to be enriched with new features. An attempt in this sense has been made by developing the questionnaire on the ideal rail regulator characteristics, formalised on the basis of the most recent findings in this area, and potentially able to complement the regulation index results. For example, the questionnaire responses cover the implementation of the measures on economic regulation and regulators' role envisaged by the Recast, which is not analysed by the regulation index. Clearly, this enhancing process needs continuous revision, which should not stop at just attempting to expand the set of macro-areas, drivers and sub-drivers. These new additions should also be measurable and quantifiable, and the overall system of weights should be adjusted in order to account for modifications in the relative importance of the regulatory features included.

Thirdly, an intervention on the interval of the regulation index is desirable. The current dataset of the regulation index provides data for the period 2002-2010[36], accordingly shortening the interval considered for the other variables utilised in the econometric estimates. The original cost dataset indeed relies on data starting from 1994, triggering a work on the temporal extension of the regulatory data. As with the process of filling the gaps in the 2002-2010 period, this type of exercise requires a careful review of main regulatory alterations occurred across European railway systems before 2002. It should be noted that a number of sub-drivers were assigned the minimum score (equal to 1) in the Rail Liberalisation Index Report published in 2002 (IBM Business Consulting Services and Kirchner, 2002)[37]. Presumably, these scores remained unaltered in the pre-2002 period and may not require further scrutiny.

Fourthly, as pointed out previously, economic regulation presents interrelation with other characteristics of a railway system. Given the overarching connotation of the IBM and Kirchner's index, collection and manipulation of data inherent in the competition levels of European railway systems may be carried out. This would generate further indices which may

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[36] Even if the regulation index covers the period 2002-2011, data only up to 2010 was used for the econometric analysis, as the cost data for the railway systems in the sample is available until at most 2010.

[37] Approximately 44% of the data points present a score equal to 1 in the 2002 report.

replace the competition dummies currently employed econometrically, and generate more sensible data.

Fifthly, the Rail Liberalisation Index Reports, albeit providing with a unique stock of data on the European railway systems, strongly relies on the arbitrary decisions of the authors who pre-determined weights and assigned scores. This possibly represents an insurmountable limitation of this type of survey, and careful examinations need to be carried out in order to verify the reliability of the authors' interpretation, which in some cases turned out to be dubious. Therefore, efforts to augment the soundness of available data ought to be considered in future research.

6.3 Data sources and model

The regulation index represents an important policy variable which forms integral part of the dataset utilised for the econometric estimations. These are aimed to mainly provide the reader with an analysis in which the regulatory aspects might convey their significance in terms of impacts on costs. Importantly, by using a multi-faceted regulation index, as compared to simple dummy variables, this research benefits from a major innovation compared to the previous literature. While the related econometric results will be illustrated in depth in Chapter 7, herein the characteristics of the dataset will be presented.

The dataset was developed in Mizutani et. al. (2014) and earlier in van de Velde et. al. (2012) and Mizutani and Uranishi (2013). The data utilised in this study mostly derives from the UIC, as detailed by Mizutani and Uranishi (2013) (Table 6.3). Further data was provided by CER members thanks to a questionnaire aimed to check and revising the data collected by Mizutani and Uranishi (2013), while enriching the dataset with figures related to most recent years. Relevant information is traceable in van de Velde et al. (2012).

Table 6.3 Major data sources

Source: Mizutani and Uranishi (2013, p.45).

Item	Source
Costs, output measures, wage, number of employees, energy price, energy consumption, rolling stock, route length, etc.	International Railway Statistics by the UIC
	Jane's World Railways
	"Energy Prices and Taxes" by International Energy Agency (IEA)
	"Supply, Transformation, Consumption – Rail" by Eurostat
	Annual reports by each individual railway organisation
	Danish Ministry of Transport for missing data of Danske Statsbaner (DSB) and Banedanmark (BDK)
Exchange rate	Eurostat
GDP deflator	World Development Indicators by the World Bank
	Economic Outlook 83 Database by OECD

The analysis in this research, as opposed to the above studies, only involves the time period and countries analysed by the IBM and Kirchner's index. The sample includes 18 European railways for the period 2002-2010, and is therefore smaller than that used in Mizutani et. al. (2014), which covered earlier years and also contained non-European railways. However, since the focus is on the impact of European legislation, the sample can be deemed to be appropriate. In total 130 observations are considered. The railway systems and the regulatory bodies included in the sample are listed in Table 6.4.

Table 6.4 Country networks and transport (or rail) regulatory body

Country network	Interval	Number of observations	Regulatory body	Institutional model
Austria (ÖBB)	2002-2010	9	Schienen-Control Gmbh (monitoring) Schienen-Control Kommission (complaints)	Special regulatory authority
Belgium (NMBS / SNCB)	2002-2007	6	Dienst Regulering van het Spoorwegvervoer en van de Exploitatie van de Luchthaven Brussel-Nationaal / Service de Régulation du Transport Ferroviaire et de l'Exploitation de l'Aéroport de Bruxelles	Special regulatory authority
Denmark (DSB)	2002-2007	6	Jernbanenævnet / Danish Rail Regulatory Body	Special regulatory authority

Country network	Interval	Number of observations	Regulatory body	Institutional model
Finland (VR)	2002-2010	9	Liikenteen Turvallisuusvirasto / Finnish Transport Safety Agency (TRAFI)	Special regulatory authority
France (SNCF)	2002-2007	6	Autorité de Régulation des Activités Ferroviaires et Routières (ARAFER)	Special regulatory authority
Germany (DB AG)	2002-2010	9	Bundesnetzagentur / Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway	Special regulatory authority
Greece (OSE)	2002-2007	6	Regulatory Authority for Railways (RAS)	Special regulatory authority
Ireland (CIE)	2002-2007	6	No regulatory body	-

Country network	Interval	Number of observations	Regulatory body	Institutional model
Italy (FS)	2002-2007	6	Autorità di Regolazione dei Trasporti (ART) / Transport Regulation Authority	Special regulatory authority
Luxembourg (CFL)	2002-2007	6	Institut Luxembourgeois de Régulation (ILR)	Special regulatory authority
Netherlands (NS)	2002-2010	9	Autoriteit Consument & Markt (ACM) / Authority for Consumers & Markets	Special regulatory authority
Norway (NSB)	2002-2009	8	Statens Jernbanetilsyn (SJT) / Norwegian Railway Authority	Railway Authority
Portugal (CP)	2002-2007	6	Autoridade da Mobilidade e dos Transportes (AMT)	Special regulatory authority

Country network	Interval	Number of observations	Regulatory body	Institutional model
Spain (RENFE)	2002-2007	6	Comisión Nacional del Mercado y la Competencia (CNMC) Direccion de Transportes y del Sector Postal Subdirección del Sector Ferroviario	Special regulatory authority
Sweden (SJ)	2002-2007	6	Transportstyrelsen - Swedish Transport Agency	Special regulatory authority
Switzerland (BLS)	2002-2010	9	Railways Arbitration Commission (RACO) / Schiedskommission im Eisenbahnver (SKE)	Ministry

Country network	Interval	Number of observations	Regulatory body	Institutional model
Switzerland (SBB / CFF / FFS)	2002-2010	9	Railways Arbitration Commission (RACO) / Schiedskommission im Eisenbahnver (SKE)	Ministry
United Kingdom (TOC)	2002-2009	8	Office of Rail and Road (ORR)	Special regulatory authority
All observations	2002-2010	130		

Moving to the model formalisation, the approach adopted in Mizutani and Uranishi (2013) and Mizutani et. al. (2014) is followed. The analysis in those papers is based around two models: a single-output model, denoted by a hedonic examination of the two services (passenger and freight transport); and a multiple-output model, with separate variables for both types of operations. A special multiple-output model is added as set out below. A translog total cost function is employed, deemed to enjoy more flexibility than other solutions such as the Cobb-Douglas model, which implies constant elasticities and substitution elasticity equal to unity for all companies.

The models and the variables are conceived upon conditions that need to be underlined. The total cost measure is equal to the sum of the total infrastructure costs of the main network manager[38] and the costs incurred by the totality of passenger and freight companies operating on that system. While the computation of this cost measure is straightforward for integrated organisations, in the case of separated entities, the infrastructure charges are subtracted before inserting the data for railway operators to avoid double counting. This and further precautions involving the computation of costs in the dataset are included in Mizutani and Uranishi (2013), and Mizutani et al. (2014). In particular, it is important to consider issues regarding the inclusion, for those countries with relatively high levels of entry, of the costs of new operators. Considering the market share of the incumbents, the related cost data have been scaled up to generate values approximating the total train operating company costs for the whole country. This nevertheless is based on the assumption that the different types of operators (incumbents and new entrants) are characterised by the same cost structure, when in reality this may not be the case, as aspects such as economies of scale or density, or efficiency levels may be greatly dissimilar. However, since this manipulation only concerns a few countries, it does not seem that the selected approach would bias the results to a great extent.

Another prominent aspect concerns the choice around the type of output measurements. Following Mizutani and Uranishi (2013) and Mizutani et. al. (2014), models with total train km (for single-output function) and with revenue passenger km and revenue tonne km (for multiple-output function) are employed. These types of measures are widely utilised by the

[38] Only for Switzerland, two main network managers are present.

literature, as highlighted by Mizutani and Uranishi (2013). In addition to these, a third model is introduced, with two separate outputs, but defined as passenger and freight train km, rather than passenger km and freight tonne km. This third model is justified by the consideration that costs produced by the formation of the railway outputs are only partially accounted for by measurements centred on passenger km and freight tonne km. These presumably fail to accurately determine the costs incurred when specific loads underutilise the train capacity, raising issues in respect to journeys characterised by partly occupied or empty wagons. With disaggregated train km instead, the overall costs generated by moving trains are incorporated, counteracting difficulties arising from variations in loads, and contributing to the harmonisation of the outputs produced by journeys serving greatly differing amounts of passengers and goods.

Moving to policy variables, issues regarding their potential endogeneity do not seem to be a problem. Changes in structure and regulation of railways have been driven by political aims rather than by economic logic. Reforming impulse have come primarily from the European Commission, and policy decisions therefore derive from variables outside the sample, neutralising problems related to endogeneity, along the same lines as past literature on railway reforms.

Prior to the illustration of these and remaining variables involved in the cost equations, it is useful to provide their mathematical representation, based on the single-output model (Model 1) from which the multiple-output models derive (Models 2 and 3):

(Model 1 – total train km):

$$\ln TC = \alpha_0 + \alpha_Y \ln Y + \sum_j \beta_j \ln w_j + \gamma_N \ln N + \tau_T T + \left(\frac{1}{2}\right) \alpha_{YY} (\ln Y)^2 + \sum_j \alpha_{Yj} (\ln Y)(\ln w_j) + \alpha_{YN} (\ln Y)(\ln N) + \alpha_{YT} (\ln Y)(T) + \left(\frac{1}{2}\right) \sum_k \sum_j \beta_{jk} (\ln w_j)(\ln w_k) + \sum_j \beta_{jN} (\ln w_j)(\ln N) + \sum_j \beta_{jT} (\ln w_j)(T) + \left(\frac{1}{2}\right) \gamma_{NN} (\ln N)^2 + \gamma_{NT} (\ln N)(T) + \left(\frac{1}{2}\right) \tau_{TT} (T)^2 + (\delta_{VS1} + \delta_{VS2} \ln V + \delta_{VS3} \ln R + \delta_{VS4} \ln REG) D_{VS} + \delta_{VI} D_{VI} + \delta_{HS} D_{HS} + \delta_{REG} REG + \delta_{CMP} CMP + \delta_{CF} D_{CF} \quad (1)$$

$$\ln Y = \ln Q + \sum_f \eta_f \ln H_f \quad (2)$$

(Model 2 – revenue passenger km and revenue ton km):

$$\ln TC = \alpha_0 + \sum_m \alpha_m \ln Q_m + \sum_j \beta_j \ln w_j + \gamma_N \ln N + \tau_T T + \left(\frac{1}{2}\right) \sum_n \sum_m \alpha_{mn} (\ln Q_m)(\ln Q_n) + \sum_j \sum_m \alpha_{mj} (\ln Q_m)(\ln w_j) + \sum_m \alpha_{mN} (\ln Q_m)(\ln N) + \sum_m \alpha_{mT} (\ln Q_m)(T) + \left(\frac{1}{2}\right) \sum_k \sum_j \beta_{jk} (\ln w_j)(\ln N) + \sum_j \beta_{jT} (\ln w_j)(T) + \left(\frac{1}{2}\right) \gamma_{NN} (\ln N)^2 + \gamma_{NT} (\ln N)(T) + \left(\frac{1}{2}\right) \tau_{TT} (T)^2 + (\delta_{VS1} +$$

$\delta_{VS2} \ln V + \delta_{VS3} \ln R + \delta_{VS4} \ln REG) D_{VS} + \delta_{VI} D_{VI} + \delta_{HS} D_{HS} + \delta_{REG} \ln REG +$
$\delta_{CMP} CMP + \delta_{CF} D_{CF}$ (3)

(Model 3 – disaggregated train km):

$\ln TC = \alpha_0 + \sum_m \alpha_m \ln Y_m + \sum_j \beta_j \ln w_j + \gamma_N \ln N + \tau_T T +$
$\left(\frac{1}{2}\right) \sum_n \sum_m \alpha_{mn} (\ln Y_m)(\ln Y_n) + \sum_j \sum_m \alpha_{mj} (\ln Y_m)(\ln w_j) +$
$\sum_m \alpha_{mN} (\ln Y_m) (\ln N) + \sum_m \alpha_{mT} (\ln Y_m)(T) + \left(\frac{1}{2}\right) \sum_k \sum_j \beta_{jk} (\ln w_j)(\ln N) +$
$\sum_j \beta_{jT} (\ln w_j)(T) + \left(\frac{1}{2}\right) \gamma_{NN} (\ln N)^2 + \gamma_{NT} (\ln N)(T) + \left(\frac{1}{2}\right) \tau_{TT} (T)^2 + (\delta_{VS1} +$
$\delta_{VS2} \ln V + \delta_{VS3} \ln R + \delta_{VS4} \ln REG) D_{VS} + \delta_{VI} D_{VI} + \delta_{HS} D_{HS} + \delta_{REG} \ln REG +$
$\delta_{CMP} CMP + \delta_{CF} D_{CF}$ (4)

$\ln Y_m = \ln Q_m + \sum_{f=1}^{g} \eta_f \ln H_f$ (5)

$\ln Y_n = \ln Q_n + \sum_{f=1}^{s} \eta_f \ln H_f$ (6)

and where TC: total cost, Y: output measure, Q: total quantity of output (total train km); Q_P: quantity of passenger output (revenue passenger km), Q_F: quantity of freight output (revenue tonne km), Q_{PTKM}: quantity of passenger output (disaggregated train km), Q_{FTKM}: quantity of freight output (disaggregated train km), H_f: characteristics of output ($f = PR$ (passenger revenue share), LF (load factor of passenger service), PTL (passenger travel length), FRC (number of freight cars per train), g = PTL, PXC (number of passenger cars per train), s = FRC), w_j: input factor price (j (or k) = L (labour), E (energy), M (material), K (capital)), N: total route length, T: technology (percentage of electrified length), V: train density, D_{VS}: vertical separation dummy (vertical separation = 1, otherwise = 0), D_{HS}: horizontal (passenger-freight) separation dummy (horizontal separation = 1, otherwise = 0), D_{VI}: vertical integration (vertical integration = 1, otherwise = 0), CMP: measure of passenger competition (0 = no competition, 1-4 based on extent of competition), D_{CF}: freight entry dummy (actual entry has occurred = 1, otherwise = 0), REG: regulation index.

A list of definitions of all variables for the three models is provided in Table 6.4. The alterations for Model 2 (revenue passenger km and revenue tonne km) and Model 3 (disaggregated train km), in comparison with Model 1, concern the different variables for the outputs and the outputs hedonic characteristics, as detailed in the next Section. As attested above, the functional form remains the same.

Constraints are incorporated in the models affecting input prices[39], such that $\sum_j \beta_j = 1,\ \sum_k \beta_{jk} = 0, \sum_j \beta_{jN} = 0, \sum_j \beta_{jT} = 0, \sum_j \alpha_{Yj} = 0, \sum_j \alpha_{mj} = 0,$ $\beta_{jk} = \beta_{kj}, \beta_{jN} = \beta_{Nj}, \beta_{jT} = \beta_{Tj}, \alpha_{Yj} = \alpha_{jY}, \alpha_{YN} = \alpha_{NY}, \alpha_{YT} = \alpha_{TY}, \alpha_{mn} = \alpha_{nm}, \alpha_{mj} = \alpha_{jm}, \alpha_{mN} = \alpha_{Nm}, \alpha_{mT} = \alpha_{Tm}, \gamma_{NT} = \gamma_{TN}$. Also, Shephard's Lemma is applied to the total cost function, from which the input share equations are obtained as follows:

(Model 1):

$$s_j = \beta_j + \alpha_{Yj}(\ln Y) + \sum_k \beta_{jk}(ln\, w_k) + \beta_{jN}(lnN) + \beta_{jT}(T) \quad (7)$$

(Models 2 and 3):

$$s_j = \beta_j + \sum_m \alpha_{mj}(ln\, Q_m) + \sum_k \beta_{jk}(ln\, w_k) + \beta_{jN}(lnN) + \beta_{jT}(T) \quad (8)$$

where s_j: input j's share of total cost.

6.4 Estimation method and characteristics of the variables

The estimations are performed by employing the seemingly unrelated regressions (SUR) method to the total cost function and the input share equations. In order to facilitate the interpretation of the coefficients, the observations of each variable are divided by the sample mean.

Table 6.5 reports the characteristics of the variables included in the model. Total cost (TC) represents the sum of costs deriving from utilising labour, energy, material and capital. In conformity to what specified in Section 6.3, infrastructure charges imposed to railway undertakings belonging to vertically separated contexts are not taken into account. This avoids double counting, as the total costs of infrastructure companies are already computed as part of the total system cost measure.

Output measures involve revenue passenger km (Q_P) and revenue tonne km (Q_F) - as in previous literature as well[40] - and total train km, as considered by Mizutani and Uranishi (2013). An additional specification is given by disaggregated train km, separated for the two types of services (passenger, Q_{PTKM}, and freight, Q_{FTKM}). The latter models, based on total and disaggregated train km, are accompanied by output characteristics. For total train km, this is carried out for the purpose of avoiding estimation

[39] For a full list of the constraints imposed, the reader can refer to the example provided in Baum and Linz (2009), based on the utilisation of the software Stata.

[40] See Cantos and Maudos (2001), Mancuso and Reverberi (2003), Farsi et al. (2005) and Mizutani and Uranishi (2013).

bias caused by the different kinds of outputs, whilst for disaggregated train km the rationale lies on the attempt to include the best features of the single and multiple-output models. Including some of the hedonic output characteristics in a multiple-output model is argued to enrich the specifications utilised by past contributions, by simultaneously considering physical measures of the output (disaggregated train km, passenger travel length and number of cars per passenger and freight trains), financial factors (passenger revenue share) and intermediate aspects (load factor of passenger services).

Table 6.5 Definition of variables used for the estimation of cost function[41]

Variable	Definition	Unit	Mean	Standard deviation	Minimum	Maximum
TC (total cost)	Sum of labour, energy, material and capital cost	Million Euro	5,767	7,266	262	26,492
Q (total output)	Total train km	Thousand km	198,480	263,704	6,899	1,029,699
Q_P (passenger output)	Passenger km	Thousand km	19,238	24,735	262	82,837
Q_F (freight output)	Tonne km	Thousand km	16,461	24,797	129	115,652
Q_{PTKM} (passenger output)	Train km	Thousand km	151,833	194,791	5,516	717,902
Q_{FTKM} (freight output)	Train km	Thousand km	35,906	47,741	971	198,206

[41] For full notes on the construction of these variables, the reader may refer to Mizutani and Uranishi (2013) and van de Velde et al. (2012).

Variable	Definition	Unit	Mean	Standard deviation	Minimum	Maximum
w_L (wage)	Labour costs per employee	Euro	50,331	15,123	20,343	92,492
w_E (energy price)	Energy price per 1000 TOE	Euro	650,917	177,508	366,442	1,290,508
w_M (material price)	Material costs per rolling stock	Euro	72,140	57,849	6,462	322,519
w_K (capital price)	Capital costs per route length	Euro	239,122	174,308	12,507	798,211
N (total route length)	Total route km	Km	8,662	9,853	241	36,044
T (technology index)	Percentage of electrified lines	%	59.81	27.45	2.72	100.00
H_{PR} (passenger revenue share)	Share of passenger revenue to total revenue	-	0.7990	0.0883	0.6235	0.9527
H_{LF} (load factor of passenger)	Passenger per train to capacity	-	0.3320	0.1193	0.1264	0.6866

Variable	Definition	Unit	Mean	Standard deviation	Minimum	Maximum
H_{PTL} (passenger travel length)	Revenue passenger km per passenger	Km	59.13	48.39	14.64	267.21
H_{PXC} (average passenger train length)	Number of passenger cars per train	Car	4.97	1.09	2.91	7.64
H_{FRC} (average freight train length)	Number of freight cars per train	Car	19.04	6.49	6.67	52.20
V (train density)	Train km per route length per day	-	66.06	36.96	18.67	159.75
D_{VS} (vertical separation)	Vertical separation dummy (vertical separation = 1)	-	0.4692	0.5010	0.0000	1.000
D_{VI} (vertical integration)	Vertical integration dummy (vertical integration = 1)	-	0.3231	0.4695	0.000	1.000
D_{HC} (holding company)	Holding company dummy (omitted)	-	-	-	-	-

Variable	Definition	Unit	Mean	Standard deviation	Minimum	Maximum
D_{HS} (horizontal separation)	Horizontal separation dummy (horizontal separation = 1)	-	0.3462	0.4776	0.000	1.000
R (proportion of freight revenues)	Freight revenues to total revenues	%	31.38	16.18	6.31	69.44
REG (regulation index)	Manipulated scores from Rail Liberalisation Index reports	-	7.30	2.29	1.51	9.85
CMP (passenger competition)	Passenger competition (0 = no competition, 1~4)	-	1.2846	1.2466	0.000	4.000
D_{CF} (freight competition)	Freight competition dummy (freight competition = 1)	-	0.5846	0.4947	0.000	1.000

The output characteristics are represented by passenger revenue share (H_{PR}), load factor of passenger service (H_{LF}), passenger travel length (H_{PTL}), number of freight cars per train (H_{FRC}) and number of passenger cars per train (H_{PXC}). H_{PR}, H_{LF}, H_{PTL} and H_{FRC} are part of total train km specification, and H_{PTL}, H_{FRC} and H_{PXC} are included with disaggregated train km. While the selection of the output variables for total train km reflects what is taken into account by Mizutani and Uranishi (2013), the choice for the model with separate passenger and freight train km involves the exclusion of passenger revenue share (H_{PR}) and the replacement of load factor for passenger transport (H_{LF}) with number of passenger cars per train (H_{PXC}). The removal of H_{PR} is justified by the fact that the shares of passenger and freight traffic are allowed for directly in the disaggregated train km variables. Replacing load factor of passenger service (H_{LF}) with number of passenger cars per train (H_{PXC}) is led by the belief that it is the formation of the train rather than the number of passengers carried that is the primary influence on costs. The way these hedonic variables are calculated is summarised in Table 6.5 following Mizutani and Uranishi (2013). Passenger revenue share (H_{PR}) represents the ratio of revenues from passenger transport to total rail transport revenues. More complex is the derivation for passenger load factor (H_{LF}), which is obtained by dividing the number of passenger per train by the designated capacity of a passenger vehicle. The numerator term is the result of revenue passenger km over passenger train km. Capacity, in turn, is the product between the number of vehicles per train and number of seats per passenger vehicle. Passenger travel length (H_{PTL}) is the ratio of revenue passenger km to the total number of passengers. Number of freight cars per train (H_{FRC}) consists of gross tonne km of freight transport divided by train km of freight transport, assuming that the weight of a freight car is 50 tons per vehicle. Lastly, the added variable, number of passenger cars per train (H_{PXC}), is defined as gross passenger km of passenger service divided by train km of passenger service.

Also for input prices (labour, energy, materials and capital), control variables (network length and technology) and density, details of the related mathematical constructions are provided in line with Mizutani and Uranishi (2013) and summarised in Table 6.5. Labour price (w_L) is equal to labour costs over total number of employees. Energy price (w_E) represents energy expenditures divided by the energy consumption measure which,

already utilised by many studies in the past[42], is defined by TOE[43]. Material price (w_M) is computed by dividing service and material expenditures by rolling stock, while capital price (w_K) is equal to capital cost per route length[44]. In particular, depreciation, amortisation, value adjustments provision for contingencies, and financial expenses as interest payments compose the capital costs[45].

Moving to the control variables, total route length (N) is simply calculated as total route km, whereas technology (T) is the percentage of electrified lines. Technology is also utilised as time trend variable, assuming that the technological progress of the railway systems is linear and their access to technological innovations is equal (following Mizutani and Uranishi, 2013). Lastly, density (V) is the result of the division of the number of train km by N and, in turn, by 365 in order to obtain a per-day variable.

Among the policy and environmental variables, the proportion of freight in total revenues (R) is the ratio of revenues from freight transport to total rail transport revenues. Vertical and horizontal separations are respectively expressed by D_{VS} and D_{HS}: they assume value equal to 1 when these structural conditions are present in a particular railway system and 0 otherwise. Competition dummies are indicated by CMP for passenger markets and by D_{CF} for freight markets: the computations of these variables are defined in Mizutani et al. (2014) and outlined in Table 6.5. As explained by the authors, CMP is a rather composite index attempting to measure the degree of passenger competition in a more sophisticated and accurate manner than what was measured in past studies, in order to take into account the extent of entry. It consists of four dummies (0-1), reporting for increasing levels of competition:

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[42] As pointed out by Mizutani and Uranishi (2013) with reference to Christopoulos et al. (2000, 2001), Kim and Kim (2001), Loizides and Tsionas (2002), Mancuso and Reverberi (2003), and Smith (2006).

[43] TOE, as explained by Mizutani and Uranishi (2013, p.48), is a Eurostat's energy index accounting for caloric values (MJ) for each energy source. Related European railway data are also available from Eurostat.

[44] Computations for material price and capital price follow Cowie (2002) and Kim and Kim (2001), as indicated by Mizutani and Uranishi (2013).

[45] In Mizutani and Uranishi (2013), alternative models were constructed based on the combination of energy and material costs, but were not selected as preferred models, in favour of those with four input prices.

1) The first level accounts for the possibility for competition to occur and for the effects produced by competition threats;
2) The second level records the presence of a small proportion of the network (around 10%) which has been allocated through open access or tendering procedures;
3) The third level moves a step forward, by considering contexts wherein around 25% of the network has experienced competition;
4) In the fourth level, competition is spread throughout the whole network.

By summing the individual dummies, an overall measure is then obtained for each railway system. Freight competition (D_{CF}) measurement also attempts to record actual entry, by assigning value equal to 1 when this has occurred and 0 otherwise.

In the model the holding company structure represents the omitted dummy variable: that implies that railway systems in the sample are categorised as having vertical separation, vertical integration, or none of these. Additional variables are vertical integration (D_{VI}), measured by a dummy assuming value of 1 when vertical separation and holding company configurations are not present (and 0 otherwise), and regulation index (REG), the construction of which was explained previously[46].

6.5 Economic rationale behind the model choice

After illustrating the model and variables from which the econometric estimations are generated, it may be worthy delineating what is expected from these estimations, in order to then verify which results are in line with previous literature and which are unforeseen. This Section will present this brief discussion, by concentrating on the effects of the so-called policy variables on cost levels, onto which most of the interest is placed.

The a priori expectations regarding regulation, which represents the critical variable of this study, are to be investigated from two points of view: the effects of this variable when considered on its own on the one hand, and

[46] It should be noted at this point that the decision of interacting regulation only with vertical separation follows different attempts to include interactions with other variables (density, freight revenue share, vertical integration and horizontal separation). These were excluded as a consequence of their moderate statistical significance or their counterintuitive sign or magnitude.

when the interaction with vertical separation and the introduction of competition are considered on the other. On the direct interventions, the regulators' control may produce a better employment of financial resources, investment strategies and quality of performance on the part of the infrastructure managers. These activities, while determining more efficient practices in deficient systems, may overburden the network managers' operations in those better functioning contexts, generating regulatory costs which are not justified by actual necessities.

Similar considerations arise with regards to the indirect repercussions supporting competition. Ensuring non-discriminatory access together with fair charges and capacity allocation may lead to the entrance of new actors able to compete with incumbents, facilitating the reduction of costs in the industry. Nonetheless, it should be noted that losses in economies of density may occur for a given traffic level when on-track competition takes place. On the other hand, when actual competition does not occur, even if allowed by the legislation, the employment of regulatory resources targeting the promotion of non-discriminatory practices may appear redundant and, again, financially unjustified.

Vertical separation represents another variable whose characteristics can be observed positively and negatively from the point of view of efficiency, as pointed out by van de Velde et al. (2012) and Mizutani et al. (2014). The level of interdependence between the infrastructure manager and the train operating companies can be particularly high, especially when decisions on investments, access and timetabling, and real-time operations need to be taken. Here the regulatory presence may play the role of an impartial third party overseeing the transaction process, pointing to the safeguard of non-discriminatory principles in integrated (or holding company) structures and to the reduction of transaction costs created by unbundled configurations. However, it is possible that even a strong regulator may not adequately overcome the potentially discriminatory behaviour of an integrated incumbent. Of course, it may also be argued that, on the contrary, when the mechanisms dealing with transactions between different parties, and within the same holding company structure, are well oiled, the presence of a regulatory third party may be superfluous, generating unnecessary costs.

Therefore, there seems not to be an unequivocal expectation on the impact of regulation role, though overall it is expected to bring about a reduction in costs. However, regulation and its impacts will be closely interrelated with the structural setting and the degree of competition. The econometric

model results, presented in the next Chapter, aim to shed some light on these points.

Chapter 7
Econometric results

7.1 Introduction

Following the presentation of the methodological approach and the total cost function models, this Chapter will illustrate the results obtained from the econometric estimations. These results will be discussed, particularly focusing on the effects of the regulation index on efficiency. This focus will help to determine the impacts of the reforms affecting economic regulation on the level of costs of a sample of European railway systems, which represents the overall aim of the thesis. Understanding the size of the regulatory impacts will be relevant when policy implications will be drawn in the concluding Chapter 8, where also qualitative findings emerged from the questionnaire on rail regulation will be deeply analysed.

In the next Section (7.2), considerations on the general statistics of the models and on the results of the traditional production-related variables will be presented. Section 7.3 will instead focus on the policy variables, central to the objectives of this paper. Conclusions are provided in Section 7.4.

7.2 General statistics properties and production-related variables

The SUR econometric results are presented in Table 7.1, subdivided according to the specifications taken into account. Moreover, Table 7.2 presents a comparison between the coefficients characterising a number of key variables in the preferred model of this study and those reported by the previous literature. Starting from the three original models based on the different types of output measurement, these are integrated with three further models including competition dummies. Hence, six models are estimated:

(i) Case 1 (total train km with output hedonic characteristics as in Mizutani and Uranishi (2013));

(ii) Case 2 (revenue passenger km and revenue tonne km as in Mizutani and Uranishi (2013));

(iii) Case 3 (disaggregated train km with a new output hedonic characteristic variable);

(iv) Case 4 (Case 1 + competition dummies);

(v) Case 5 (Case 2 + competition dummies);

(vi) Case 6 (Case 3 + competition dummies).

Table 7.1 Full econometric estimation results

Variable	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Q	0.5735*** (0.0829)	-	-	0.6236*** (0.0936)	-	-
Q_P	-	0.1695*** (0.0575)	-	-	0.1840*** (0.0577)	-
Q_F	-	0.3657*** (0.0466)	-	-	0.3693*** (0.0463)	-
Q_{PTKM}	-	-	0.3102*** (0.0753)	-	-	0.3516*** (0.0741)
Q_{FTKM}	-	-	0.2374*** (0.0549)	-	-	0.2567*** (0.0549)
H_{PR}	-0.1941 (0.1489)	-	-	-0.1909 (0.1557)	-	-
H_{LF}	-0.3608*** (0.0599)	-	-	-0.3073*** (0.0664)	-	-
H_{PTL}	0.1817*** (0.0299)	-	0.0991** (0.0507)	0.1726*** (0.0298)	-	0.0950** (0.0492)

Variable	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
H_{PXC}	-	-	-0.3899*** (0.0886)	-	-	-0.4348*** (0.0873)
H_{FRC}	0.0855** (0.0445)	-	0.3384*** (0.0510)	0.0713 (0.0456)	-	0.2907*** (0.0526)
w_L	0.3261*** (0.0090)	0.3373*** (0.0078)	0.3297*** (0.0082)	0.3261*** (0.0090)	0.3367*** (0.0078)	0.3296*** (0.0082)
w_E	0.0437*** (0.0031)	0.0452*** (0.0028)	0.0433*** (0.0029)	0.0438*** (0.0031)	0.0454*** (0.0028)	0.0433*** (0.0028)
w_M	0.2601*** (0.0079)	0.2578*** (0.0073)	0.2614*** (0.0073)	0.2597*** (0.0079)	0.2574*** (0.0073)	0.2618*** (0.0072)
w_K	0.3701*** (0.0086)	0.3597*** (0.0088)	0.3655*** (0.0079)	0.3703*** (0.0086)	0.3605*** (0.0088)	0.3653*** (0.0079)
N	0.4719*** (0.0899)	0.4849*** (0.0852)	0.4794*** (0.0962)	0.4364*** (0.0940)	0.4913*** (0.0845)	0.4663*** (0.0936)
T	0.2816*** (0.0626)	0.0870 (0.0760)	0.3999*** (0.0882)	0.3057*** (0.0633)	0.1036 (0.0758)	0.4665*** (0.0873)

Variable	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
$Q \cdot Q$	0.2205 (0.1500)	-	-	0.1700 (0.1497)	-	-
$Q_P \cdot Q_P$	-	0.3349*** (0.0934)	-	-	0.2765*** (0.0980)	-
$Q_F \cdot Q_F$	-	-0.1362 (0.1016)	-	-	-0.1139 (0.1059)	-
$Q_{PTKM} \cdot Q_{PTKM}$	-	-	0.3126*** (0.1198)	-	-	0.3674*** (0.1199)
$Q_{FTKM} \cdot Q_{FTKM}$	-	-	-0.0564 (0.1097)	-	-	-0.0855 (0.1076)
$N \cdot N$	-0.2647 (0.1737)	-0.3525 (0.2324)	-0.8433*** (0.2349)	-0.4221** (0.1902)	-0.4568** (0.2413)	-0.9455*** (0.2282)
$w_L \cdot w_L$	0.1476*** (0.0196)	0.1705*** (0.0169)	0.1272*** (0.0196)	0.1472*** (0.0195)	0.1708*** (0.0169)	0.1281*** (0.0195)
$w_L \cdot w_E$	0.0063 (0.0070)	-0.0021 (0.0069)	0.0072 (0.0065)	0.0063 (0.0070)	-0.0022 (0.0069)	0.0062 (0.0064)

Variable	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
$w_L \cdot w_M$	-0.0508*** (0.0105)	-0.0559*** (0.0088)	-0.0454*** (0.0099)	-0.0497*** (0.0105)	-0.0563*** (0.0088)	-0.0447*** (0.0098)
$w_L \cdot w_K$	-0.1031*** (0.0124)	-0.1125*** (0.0111)	-0.0889*** (0.0128)	-0.1037*** (0.0124)	-0.1122*** (0.0110)	-0.0896*** (0.0128)
$w_E \cdot w_E$	0.0329*** (0.0053)	0.0309*** (0.0055)	0.0341*** (0.0049)	0.0329*** (0.0052)	0.0309*** (0.0054)	0.0343*** (0.0048)
$w_E \cdot w_M$	-0.0135*** (0.0038)	-0.0082*** (0.0033)	-0.0118*** (0.0034)	-0.0134*** (0.0038)	-0.0082*** (0.0033)	-0.0117*** (0.0033)
$w_E \cdot w_K$	-0.0257*** (0.0038)	-0.0207*** (0.0037)	-0.0295*** (0.0041)	-0.0257*** (0.0039)	-0.0206*** (0.0037)	-0.0287*** (0.0040)
$w_M \cdot w_M$	0.1002*** (0.0092)	0.1013*** (0.0080)	0.0934*** (0.0085)	0.0988*** (0.0092)	0.1018*** (0.0080)	0.0934*** (0.0083)
$w_M \cdot w_K$	-0.0359*** (0.0079)	-0.0373*** (0.0075)	-0.0362*** (0.0075)	-0.0357*** (0.0078)	-0.0374*** (0.0075)	-0.0370*** (0.0075)
$w_K \cdot w_K$	0.1647*** (0.0113)	0.1704*** (0.0113)	0.1546*** (0.0114)	-0.0357*** (0.0078)	0.1702*** (0.0113)	0.1553*** (0.0114)

Variable	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
$Q \cdot w_L$	0.1545*** (0.0188)	-	-	0.1548*** (0.0188)	-	-
$Q \cdot w_E$	0.0171*** (0.0060)	-	-	0.0166*** (0.0061)	-	-
$Q \cdot w_M$	0.0177 (0.0140)	-	-	0.0200 (0.0140)	-	-
$Q \cdot w_K$	-0.1894*** (0.0160)	-	-	-0.1915*** (0.0160)	-	-
$Q \cdot N$	0.1011 (0.1557)	-	-	0.2130 (0.1644)	-	-
$Q \cdot T$	-0.0945 (0.0926)	-	-	-0.0521 (0.0939)	-	-
$Q_P \cdot Q_F$	-	0.0646 (0.0761)	-	-	0.0549 (0.0836)	-
$Q_P \cdot w_L$	-	0.1258*** (0.0129)	-	-	0.1258*** (0.0129)	-

Variable	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
$Q_P \cdot w_E$	-	0.0085** (0.0044)	-	-	0.0086** (0.0043)	-
$Q_P \cdot w_M$	-	-0.0034 (0.0103)	-	-	-0.0038 (0.0103)	-
$Q_P \cdot w_K$	-	-0.1310*** (0.0132)	-	-	-0.1307*** (0.0132)	-
$Q_P \cdot N$	-	-0.2448* (0.1481)	-	-	-0.1629 (0.1561)	-
$Q_P \cdot T$	-	-0.1818* (0.1006)	-	-	-0.1335 (0.1033)	-
$Q_F \cdot w_L$	-	0.0901*** (0.0135)	-	-	0.0902*** (0.0135)	-
$Q_F \cdot w_E$	-	-0.0033 (0.0050)	-	-	-0.0035 (0.0049)	-
$Q_F \cdot w_M$	-	0.0132 (0.0121)	-	-	0.0136 (0.0121)	-

Variable	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
$Q_F \cdot w_K$	-	-0.1000*** (0.0146)	-	-	-0.1003 (0.0146)	-
$Q_F \cdot N$	-	0.2741*** (0.0869)	-	-	0.2763*** (0.865)	-
$Q_F \cdot T$	-	0.1421* (0.0870)	-	-	0.1239 (0.0901)	-
$Q_{PTKM} \cdot Q_{FTKM}$	-	-	-0.1833* (0.1073)	-	-	-0.1914* (0.1055)
$Q_{PTKM} \cdot w_L$	-	-	0.1016*** (0.0168)	-	-	0.1025*** (0.0167)
$Q_{PTKM} \cdot w_E$	-	-	0.0200*** (0.0053)	-	-	0.0195*** (0.0052)
$Q_{PTKM} \cdot w_M$	-	-	0.0083 (0.0121)	-	-	0.0085 (0.0118)
$Q_{PTKM} \cdot w_K$	-	-	-0.1299*** (0.0144)	-	-	-0.1305*** (0.0144)

Variable	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
$Q_{PTKM} \cdot N$	-	-	0.15478 (0.1410)	-	-	0.1822 (0.1365)
$Q_{PTKM} \cdot T$	-	-	-0.1450 (0.0957)	-	-	-0.1273 (0.0927)
$Q_{FTKM} \cdot w_L$	-	-	0.0735*** (0.0159)	-	-	0.0739*** (0.0158)
$Q_{FTKM} \cdot w_E$	-	-	-0.0107** (0.0055)	-	-	-0.0107** (0.0054)
$Q_{FTKM} \cdot w_M$	-	-	0.0152 (0.0133)	-	-	0.0158 (0.0130)
$Q_{FTKM} \cdot w_K$	-	-	-0.078*** (0.0150)	-	-	-0.0790*** (0.0150)
$Q_{FTKM} \cdot N$	-	-	0.3768*** (0.1273)	-	-	0.4150*** (0.1236)
$Q_{FTKM} \cdot T$	-	-	0.1848*** (0.0719)	-	-	0.2075*** (0.0699)

Variable	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
$w_L \cdot N$	-0.1627*** (0.0176)	-0.2404*** (0.0185)	-0.1803*** (0.0158)	-0.1626*** (0.0175)	-0.2408*** (0.0186)	-0.1810*** (0.0157)
$w_L \cdot T$	-0.0321 (0.0097)	-0.0823*** (0.0125)	-0.0574*** (0.0111)	-0.0327*** (0.0096)	-0.0831*** (0.0125)	-0.0584*** (0.0111)
$w_E \cdot N$	-0.0111** (0.0057)	-0.0006 (0.0065)	-0.0026 (0.0055)	-0.0106* (0.0058)	-0.0005 (0.0064)	-0.0023 (0.0053)
$w_E \cdot T$	0.0019 (0.0034)	0.0070 (0.0047)	0.0099*** (0.0040)	0.0021 (0.0034)	0.0073 (0.0046)	0.0097*** (0.0039)
$w_M \cdot N$	-0.0186 (0.0136)	-0.0158 (0.0154)	-0.0251* (0.0134)	-0.0210 (0.0136)	-0.0156 (0.0154)	-0.0257** (0.0131)
$w_M \cdot T$	0.0201*** (0.0084)	0.0182* (0.0112)	0.0131 (0.0096)	0.0194** (0.0084)	0.0174 (0.0112)	0.0135 (0.0094)
$w_K \cdot N$	0.1924*** (0.0153)	0.2568*** (0.0188)	0.2080*** (0.0146)	0.1942*** (0.0153)	0.2569*** (0.0188)	0.2089*** (0.0145)
$w_K \cdot T$	0.0101 (0.0091)	0.0570*** (0.0133)	0.0345*** (0.0107)	0.0113 (0.0091)	0.0585*** (0.0133)	0.0353*** (0.0107)

Variable	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
$N \cdot T$	0.3283*** (0.0972)	0.0213 (0.1341)	0.0024 (0.1306)	0.2840*** (0.0978)	-0.0036 (0.1334)	0.0129 (0.1266)
$T \cdot T$	-0.0766 (0.0746)	-0.0851 (0.1114)	0.0620 (0.0802)	-0.0972 (0.0748)	-0.0952 (0.1140)	0.0199 (0.0785)
D_{VS}	0.0267 (0.0601)	-0.1314 (0.0846)	-0.1047 (0.0895)	0.1041 (0.0674)	-0.1108 (0.0953)	-0.0169 (0.0932)
$V \cdot D_{VS}$	0.3514*** (0.1036)	0.4758*** (0.1128)	0.2359 (0.1487)	0.3877*** (0.1028)	0.4915*** (0.1185)	0.3258** (0.1469)
$R \cdot D_{VS}$	0.0209 (0.0609)	-0.1322** (0.0686)	-0.1087 (0.0725)	0.0898 (0.0664)	-0.0827 (0.0767)	-0.0342 (0.0739)
D_{VI}	-0.0098 (0.0415)	0.0491 (0.0383)	0.0544 (0.0415)	0.0022 (0.0418)	0.0528 (0.0381)	0.0635 (0.0411)
D_{HS}	-0.3433*** (0.0432)	-0.2698*** (0.0583)	-0.3756*** (0.0556)	-0.3054*** (0.0582)	-0.1965*** (0.0723)	-0.3041*** (0.0617)
REG	-0.1232** (0.0530)	0.0613 (0.0444)	0.0499 (0.0525)	-0.1200** (0.0529)	0.0823* (0.0461)	0.0741 (0.0527)

Variable	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
$REG \cdot D_{VS}$	0.0423 (0.0937)	-0.2412*** (0.0840)	-0.3278*** (0.0966)	0.0840 (0.1047)	-0.1515 (00964)	-0.2143** (0.1041)
CMP	-	-	-	-0.0414* (0.0250)	-0.0338** (0.0176)	-0.0684*** (0.0210)
D_{CF}	-	-	-	0.0661** (0.0334)	-0.0048 (0.0351)	0.0584* (0.0336)
C_0	0.2554*** (0.0530)	0.2794*** (0.0444)	0.2947*** (0.0301)	0.2508*** (0.0442)	0.3240*** (0.0417)	0.3200*** (0.0417)
Log of likelihood	800.086	812.099	823.518	801.493	813.473	826.862
Pseudo R^2	0.991	0.991	0.989	0.991	0.991	0.990
AIC	-1522.172	-1538.197	-1555.036	-1520.986	-1536.944	-1557.725
BIC	-1410.338	-1414.893	-1423.129	-1403.417	-1407.905	-1420.083
Number of observations	130	130	130	130	130	130

Table 7.2 Historical comparison between coefficients of key variables

Study	**Sample / Interval**	**Variable**					
		REG	D_{VS}	$V \cdot D_{VS}$	D_{HS}	CMP	D_{CF}
Case 6 herein	18 European railway networks - 2002-2010	0.0741	-0.0169	0.3258**	-0.3041***	-0.0684***	0.0584*
Mizutani and Uranishi (2013)	30 European and East Asian railway organisations - 1994-2007	-	0.1123***	0.2469***	-0.2099***	-	-
van de Velde et al. (2012)	33 European and Asian railway networks - 1994-2010	-	0.0041	0.3760***	-0.2718***	-0.0081	0.0388
Cantos et al. (2012)	23 European railway networks - 2001-2008	-	-0.022	-	-	-0.087	-0.072
Wetzel (2008)	31 European railway firms - 1994-2005	-0.255**	-	-	-	0.257**	-0.253**

Models based on disaggregated train km (Cases 3 and 6) are preferred based on log likelihood, Akaike information criterion (AIC) and Bayesian information criterion (BIC)[47]. Besides the imposition of constraints to ensure homogeneity and symmetry conditions, monotonicity and global concavity were tested and verified for all the six cases. The partial derivatives of the total cost function with respect to output and input factor prices turn out not to be negative, therefore satisfying the monotonicity requirements at the sample mean for all the six cases. In relation to global concavity in input prices, for all the six cases Hessian matrices were constructed in order to determine whether their eigenvalues are nonpositive. Albeit around 75% of observations conform to concavity[48], positive eigenvalues were present, potentially forcing to impose global concavity as an ex-ante restriction, as suggested by Baum and Linz (2009). Nevertheless, this may lead to the loss in the flexibility denoting the translog function, as pointed out by the relevant literature (Coelli et al., 2005, and Baum and Linz, 2009). Also, concavity violations should not imply insurmountable issues affecting the optimisation problems, whose underlying resolution may still be achieved (Wales, 1977).

The coefficients obtained for outputs, input prices, and control variables (route length and technology) are sensible and in line with previous studies. The values of the newly introduced output measurement, based on disaggregated train km, do not particularly seem surprising as well. Moreover, most of the elasticities of the output hedonic characteristics conform to what expected. Passenger revenue share (H_{PR}) does not appear to possess high statistical significance, while passenger travel length (H_{PTL}) and average freight train length (H_{FRC}) are expected to increase costs and the related results confirm this.

The strangest result is the negative sign for passenger load factor (H_{LF}) in Case 1 and average passenger train length (H_{PXC}) in Case 3. It should be recalled that the former is based on a complex measurement of passenger per train to capacity (Mizutani and Uranishi, 2013), while the latter is simply equal to number of passenger cars per train. What is unexpected, given the other variables in the regression, is the potentially cost reducing effect deriving from the exploitation of high load factors which, intuitively, should

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[47] All specifications are denoted by high goodness-of-fit. Pseudo R^2 are all around 99%, in line with Mizutani and Uranishi (2013).

[48] This figure appears satisfactory when compared with previous literature (for instance, Mizutani and Uranishi, 2013).

increase the cost levels. Perhaps these effects arise from the benefits of particularly high-traffic contexts, even though the presence of a density variable should be able to capture them. Attempting to exclude these variables does not affect the policy implications for the multiple-output models (which, as noted above, are the preferred models) in terms of the interrelationships between regulation, competition and structure. Total train km models instead undergo significant alterations once these exclusions are carried out. Therefore, multiple-output specifications enjoy greater stability and the disaggregated train km cases (belonging to this group of specifications) gain another point in terms of model selection.

In conclusion, multiple-output cases seem to be characterised by higher stability when different specifications are considered. In line with the preference to these models accorded by van de Velde et al. (2012) and Mizutani et al. (2014), and looking at the results on general statistics earlier discussed, favouring multiple-output models over single-output models appears to be a reasonable choice. Of the disaggregated models, Cases 3 and 6 are particularly preferred, partly because they contain a simpler and more intuitive measure of passenger load factor as noted above, and partly based on the standard AIC and BIC model selection criteria already explored. The discussion on policy variables will better clarify this selection.

7.3 Policy variables

Looking into the specific results for policy variables, regulation seems to lead to reduced railway system costs; however, the way this occurs (direct or indirect) depends on the output measurement chosen. Considering firstly the models without competition dummies (Cases 1 to 3), only in the model with railway output represented only by total train km (Case 1) does regulation as such (REG) play an important role in reducing costs (direct effect). In particular, and bearing in mind that the model is logarithmic, with a statistical significance level of 5%, a 10% increase in the regulation index would produce a total costs reduction of approximately 1.2%. In the multiple-output models (Cases 2 and 3), the effect of regulation occurs only when combined with vertical separation (the coefficient of $REG * D_{VS}$ is negative and statistically significant, attesting the presence of indirect effects).

Vertical separation and vertical integration as such (D_{VS} and D_{VI}), both at the sample mean, instead are never statistically significant (relative to the holding company model). These modest results for vertical separation

confirm what was determined by previous studies (van de Velde et al., 2012 and Mizutani et al., 2014). When moving away from the sample mean level, strong and detrimental effects on costs are determined by vertical separation (relative to the holding company model) in association with higher levels of traffic (density), confirming what Mizutani et al. (2014) report. Here, however, these effects pertain to European policies only, as solely European railways are considered, ruling out any impact that the inclusion of Japanese railways may be argued to have on previous studies' findings. In addition, another recurring pattern is that horizontal separation strongly reduces costs for each of the specifications.

The inclusion of competition dummies (Cases 4 to 6) changes the scenario in a number of ways. While regulation as such (REG) reproduces similar results to the first three cases, the coefficients for the interaction between regulation and vertical separation ($REG * D_{VS}$) (in Cases 5 and 6) still document a substantial cost-reducing effect (relative to the holding company model), even if this is now slightly smaller and less statistically significant. Further tests on REG and $REG * D_{VS}$ for Cases 4 to 6 corroborate this. Their joint significance is indeed moderate, reaching values around the 10% level. Moreover, the significance of the overall effect of regulation on total costs in vertically separated systems (given by the sum of the coefficients of REG and $REG * D_{VS}$, -0.1402) is over the 10% level. The introduction of passenger competition (CMP) seems to be partly replacing this vacuum, especially in Case 6 (with disaggregated train km) where its statistical significance reaches the highest level and its coefficient the strongest size. This role for passenger competition overturns the evidence of previous studies, which tended not to find an impact from this variable. Importantly then, this study finds a cost-reducing effect for passenger competition in line with expectations. On the other hand, freight competition (D_{CF}) seems to follow similar paths indicated by past work; its statistical significance borders 5% level only in one occasion (Case 4) and its sign denotes an adverse influence on costs.

In line with previous findings (van de Velde et al, 2012 and Mizutani et al., 2014), the interaction between density and vertical separation ($V * D_{VS}$) in the disaggregated train km specification is positive and statistically significant (Case 6 compared with Case 3). Overall, with competition included in the model, the role played by density seems to be validated throughout the whole set of estimations.

In general, the introduction of competition variables has little effect on the results for single-output models (see Cases 1 and 4). Significantly, with competition included in the analysis, the multiple-output models (Cases 5 and 6) appear more realistic: the interaction between regulation and vertical separation ($REG * D_{VS}$) is still strongly beneficial in terms of efficiency, and its slightly reduced influence allows competition to play a decisive role, at least for the passenger sector. As reported previously, this is particularly true for Case 6 which best demonstrates the benefits from passenger competition.

7.4 Conclusions

In this Chapter econometric results were presented in order to assess the regulatory effects on the efficiency levels of European railways. Traditional production-related and policy variables were also estimated, thereby providing the necessary evidence to draw comparison with previous literature. The econometric results corroborate the accuracy of past findings in a number of ways, but also point out important divergences. Similarities and differences can be summarised as follows:

- The elasticities reported for input prices, outputs and control variables are in line with previous studies utilising a similar dataset (van de Velde et al., 2012 and Mizutani et al., 2014);
- The scarce significance of freight competition and vertical separation as such, together with the strong and beneficial relevance of horizontal separation on railway efficiency are also confirmed;
- This study reiterates the detrimental role played by density on costs, critically hampering the success of vertical separation;
- Regulation generally produces cost reductions, either via direct or indirect effects. However, in the preferred models (multiple-output models) the latter are exalted, observing the advantages deriving from the interaction between regulation and vertical separation, accompanied by strong passenger competition;
- Relevantly, passenger competition appears to bring down railway costs, contrasting previous findings which did not identify benefits deriving from this market reform.

As noted earlier, Cases 3 and 6 are preferred based on selection criteria and on the results and stability of these models. Finally, taking into account

the important role emerging for passenger competition in Case 6, the richer specification ultimately provides this Case with the edge.

This choice leads to take into account the policy implications originating by Case 6 findings. These will be discussed in depth in the next Chapter, where the quantitative and qualitative analyses (based on econometric and questionnaire results) will come together in order to illuminate how economic regulation and the regulators' role are and should be impacting on railway efficiency.

Chapter 8
Conclusions

8.1 Introduction

The modern era of European railways has been inaugurated by a series of reforms aimed to transform this industry. The stimulus behind this reforming wave was mainly propelled by the worrying decline affecting railways, especially in relation to the falling modal share and to the unsustainable financial conditions characterising state-owned railways. A revamp was considered necessary above all by the European Commission which, in order to guarantee the consolidation of a common economic area also for railways, decided to legislate, among the others, for a gradual liberalisation of international and national services whilst promoting organisational models detached from the previously sole form, based on vertically integrated structures.

The popular focus on the impacts of some of these reforms (for instance, structural unbundling and competition), robustly examined by many authors in the past years, has led to destine only a marginal space to the effects of the interventions on economic regulation in general, and the role played by regulators in particular. Therefore, this thesis has conducted an investigation of these regulatory effects on European railways efficiency, attempting to reach objectives which can be summarised as follows:

i. Reviewing the literature on the ideal rail regulator characteristics in order to trace those key areas around which designing a questionnaire on the role played by European rail regulators;

ii. By involving the principal actors in the European railway industry - regulators, infrastructure managers and railway undertakings -, analysing first-hand evidence on the current regulatory trends in railways;

iii. Providing a rigorous quantitative analysis of the impacts of economic regulation in railways, starting from the construction of a purposely developed regulation index;

iv. By including this index in an econometric model, measuring the effects of economic regulation on railway systems' cost efficiency;

v. Establishing whether and how strong economic regulation leads to tackle railway inefficiency and, overall, in which ways economic regulation interrelate with other important aspects connoting a railway system, such

as the structural model, the competition level and the density of the network.

This study has firstly presented an illustration of the main railway reforms implemented in the European Union in the last decades. Their effects were reviewed in terms of the different and, at times, contrasting contributions emerging from the relevant literature. Therein, the rationale behind the choice of analysing the impacts of economic regulation on the cost levels of European railways has been explained. The following literature reviews have shifted the attention on how an ideal rail regulator should look like, and on how regulation in railways can be measured, a somewhat unexplored field. The findings from the review on ideal rail regulator characteristics have been exploited in order to design a questionnaire addressed to regulators, infrastructure managers and railway undertakings across Europe. The purpose of this questionnaire was to understand how European rail regulators perform against the ideal characteristics surfacing from the literature. Moving to more quantitative exercises, the insights traced by looking at methodologies employed in non-railway but comparable industries inform the choice to measure regulation by using a newly developed regulation index. This regulation index has been included in a total cost function model, whose econometric estimations have been presented. Finally, this chapter summarises the novelties of this thesis (8.2), along with its main findings (8.3) and future strands of research (8.4). The final section (8.5) will then be dedicated to the discussion of policy implications resulting from the questionnaire responses and the econometric outcomes, providing linkages between these two analyses.

8.2 Novelties of the thesis

The qualitative and quantitative analyses of this thesis have introduced some innovations in the field of economic study of railway reforms. These can be summarised as follows:

1) By deeply examining the role played by regulators in railways, this research fills a relevant gap in the literature on the impacts of railway reforms, by combining quantitative and qualitative analyses on economic regulation and highlighting how rail regulators provide a unique function of support and safeguard of efficient market mechanisms;

2) Utilising a questionnaire addressed to regulators and other industry representatives has enabled the collection of updated and first-hand

evidence on the current status of rail regulation across Europe, particularly valuable given the several reforms implemented in recent years. This questionnaire was designed according to the findings emerged from an extensive review of the literature on the ideal rail regulator characteristics, for which similar examples were not found in this research area, suggesting that potential improvements and expansions are possible;

3) The introduction of a newly developed regulation variable aims to tackle a lack in the literature on railway reforms, accounting for regulatory characteristics which do not end with the independence of the regulators, but now embrace the activities, powers and role of these bodies as well;

4) The construction of this variable moves from the formalisation of a dummy (as elaborated by previous literature) to the definition of a composite index, conceived over selected sub-drivers from the Rail Liberalisation Index reports (IBM and Kirchner, 2002, 2004, 2007 and 2011). This leads to the creation of a panel involving 17 European countries (for the period 2002-2010), with a view to obtain a better representation of the regulatory features;

5) This index is incorporated into a translog total cost function, and estimations are performed. The models involve different types of output measurement, among which the disaggregated train km specifications - importantly introduced in addition to specifications analysed in past studies - are the preferred ones. This choice is motivated by the more sensible representation offered compared with that provided by alternative models. Regulation, structural reforms and competition are argued to be accurately captured by disaggregated train km models, especially in relation to their interdependencies, not robustly examined as parts of the same scheme by past contributions on this field.

8.3 Main findings of the thesis

Building on the innovations summarised above, this thesis has produced important results which would potentially be able to shed some light on the role played by economic regulation and regulators within the European railway systems. The main findings highlighted by this research are:

1) On the basis of the qualitative and quantitative analyses, reforms on the regulatory role are argued to have significant incidence on railway systems, in terms of beneficial effects on efficiency;

2) The results of the questionnaire allow a detailed analysis of the regulatory practices implemented by rail regulators across Europe. The related impacts for researchers and industry actors are mixed: while regulators' potential decisively improved in recent years and these bodies seem to formally reach the necessary requirements to effectively operate (as emerging from the adequate levels of independence, resources and transparency achieved, for instance), in practice regulatory powers appear variegated and cannot be considered to be fully exploited yet in the majority of the sample. This is particularly evident for crucial activities such as the approval of track access charging schemes and the monitoring of the efficiency and quality of the infrastructure managers' performance, for which several regulators play no or minimal role because multi-annual contracts are in place or other bodies (typically governments) carry out these tasks. Further strengthening these powers and role of economic regulators would seem beneficial, especially in light of what emerging from the complementing econometric results, wherein stronger economic regulation was associated with positive effects on the efficiency performance of European railway systems. Exploiting the regulators' independence, autonomy and expertise seems recommendable, considering the possibilities granted by the Recast, especially when governmental lacks require regulators to step in. More evidence on these aspects is required, possibly through the design of even larger surveying projects involving, among the others, new operators and governments;

3) The impacts of regulation on costs are analysed more precisely than previously. In the preferred model, regulation combined with vertical separation produces benefits on costs (when density is below average), and passenger competition can further improve railway efficiency. An important contribution to the literature is that strong regulation can overcome some of the negative impacts of vertical separation at higher density levels, thus increasing the proportion of railways for which vertical separation may be a sensible policy option from a cost reduction perspective. This finding will be further explored in Section 8.5.

Overall this work, while documenting the state of play of regulation practices, moves in the direction of a more bottom-up identification of the areas where (and the conditions through which) regulation, structure and competition may interact and produce advantages for the railways' efficiency. Exploring this research strand may clarify why ideal rail regulatory practices are more or less implemented in certain countries,

which is crucial in order to justify the appropriate amount of resources allocated to rail regulatory activities across Europe.

8.4 Future research

Throughout the thesis, suggestions of future strands of research have been indicated as emerging from both the qualitative and quantitative analyses. Starting with the former, the originality of the questionnaire as one of the first attempts seeking views from railway actors about the regulators' role has implied dealing with weaning difficulties. The selection of the key areas informing the design of the questionnaire is yet to be completed, and stands as one of the first attempts to deepen the understanding of regulatory mechanisms in railways. Looking at railway-related studies but also and especially at studies on comparable network industries constitutes a recommendable option in terms of tracing further key areas which may help to better clarify the role played by regulators in railways.

The risk of receiving biased answers is another delicate point which has been tried to be overcome, as explained in Chapter 4. It appears reasonable to encourage the involvement of at least two further types of actors in future surveying projects. On the one hand, involving non-incumbent operators may re-define the analysis in terms of discriminatory practices and regulatory promptness. On the other hand, involving the governments may be crucial in order to better examine those contexts wherein the regulators' scope is squeezed due to the widespread governmental presence within the railway governance.

On the whole, the choice of designing a questionnaire seemed the natural solution given the clear lack of up-to-date data and information on the regulatory state of European railways. Building on this questionnaire, developments may arise from employing different yet presumably smoother methods. At times, interviews have been utilised in this project in order to complement or update the questionnaire responses: these may ensure an appropriate alternative in future. Round tables involving diverse railway actors represent another option which, albeit logistically problematic, potentially provides with valuable debates for the research in this field.

Moving to the quantitative side of the thesis, it should be noted that typical measurement issues and potential corrective actions pertaining to the general literature on the impacts of railway reforms have previously been illustrated in Chapter 2. Here suggestions will be pointed out in relation to

the construction and employment of one of the major novelties of the econometric analysis, namely the regulation index. Relevantly, issues regarding the authors' interpretation and the subsequent scoring system have emerged and further documental reviews are needed, in order to reasonably justify at least the occurrence of the biggest regulatory changeovers within a particular railway system.

Moreover, additions or modifications may concern the sets of macro-areas, drivers and sub-drivers. Following the methodology of the questionnaire on the ideal rail regulator characteristics, designed on the basis of the most recent findings in this area, may enrich the current structure of the regulation index. It should be however borne in mind that such additions or modifications should harmoniously be inserted into the index, calling for measurable criteria and reasonable alterations in the overall system of weights.

Importantly, economic regulation presents interrelations with other characteristics of a railway system which should be considered when adding new themes in the regulation index. A sound example is given by the competitive conditions, whose exploration within the Rail Liberalisation Index reports (IBM and Kirchner, 2002, 2004, 2007 and 2011) may be carried out. Competition sub-indices may emerge from this work, potentially employable in econometric analyses in lieu of dummies.

In particular, these further sub-indices would help shed some light on the impacts of economic regulation on different passenger end-user markets, such as the long distance routes on the one hand, and the regional and urban segments on the other. As shown by the questionnaire results, "competition in the market" is actually implemented into national commercial routes in 5 countries in the sample, while "competition for the market" is typically applied by using direct awards rather than tenders. As suggested earlier, an appropriate starting point to measure competition in these sub-markets may be those specific sub-drivers included in the Rail Liberalisation Index reports (IBM and Kirchner, 2002, 2004, 2007 and 2011) which, for instance, look at the market share and at the growth in market share of external railway undertakings both in the passenger routes under public service contracts and in the purely commercial passenger routes. By analysing the interrelationships between the existing regulation index and the newly created competition sub-indices, the effects of economic regulation on costs may be better clarified and disentangled according to the competitive characteristics of national sub-markets.

Conducting this enriching analysis would potentially demonstrate its importance especially considering the future implementation of the provisions contained in the “market pillar” of the Fourth Railway Package (COM, (2013) 25, final), which is set to open the market for domestic commercial passenger transport from 2020 and make competitive tendering the norm for routes covered by public service contracts.

Besides a thematic expansion, a temporal one is encouraged. Tracing regulatory changeovers dating back to the first European reforms on railways may help to delineate how economic regulation has gradually shaped its impacts on the efficiency of European railway system. Rigour is again needed when scores are to be assigned to specific sub-drivers, calling again for documental support able to justify a particular changeover. This type of expansion would produce benefits for the econometric analysis as well since, as noted in Chapter 6, the cost data, currently used for its 2002-2010 period, is actually available from 1994 onwards and may therefore be better exploited.

A temporal expansion is certainly encouraged to cover the most recent years as well. As described in this thesis, the Recast marked an important effort in improving economic regulation and empowering the actions of regulatory bodies in European railways. Therefore, in light of these changes, there seems to emerge the necessity of quantitatively capturing the recent impacts of economic regulation and regulatory bodies’ activities on railway costs. Besides adjusting and updating cost data, highlighted by the multiple measurement problems faced by past literature, a new exercise attempting to collect up-to-date quantitative data on regulation appears essential. Replicating the data collection undertaken with the Rail Liberalisation Index reports (IBM and Kirchner, 2002, 2004, 2007 and 2011) to cover post-Recast years may be here suggested. However, this exercise should attempt, as mentioned earlier, to incorporate new themes. Looking more closely at the critical areas pointed out by the questionnaire would possibly represent a future approach, in order to appropriately quantify the degree of implementation of the Recast in individual national systems. More quantifiable details on, for instance, the role played by regulatory bodies in approving track access charging schemes, or regulating the efficiency and quality of the infrastructure managers, would potentially detect to which extent individual Member States have implemented the Recast and how their rail regulatory systems compare with each other.

Comparing different railway systems on important regulatory processes, such as those aiming to increase efficiency, represents a lesson that should be applied from practices utilised in other network industries. The studies by Haney and Pollitt (2009, 2011 and 2013) on the energy sector are here exemplary and prompt potential research exercises concerning the railway sector. Assessing whether and how regulators use incentive regulation to improve railway efficiency, identifying also what lies behind the regulators' choice, would follow the lines pursued by Haney and Pollitt surveying work (2009). Constructing a best practice index on the extent to which incentive regulation is applied, based on appropriate scores assigned to each country, would not only allow for a specific cross-country comparison on efficiency-seeking regulation, but also enrich the analysis of rail regulation captured by the overall regulation index utilised in this research.

The two remaining studies underline the relevance of understanding what influences the regulators' choice regarding the adoption of incentive regulation and international benchmarking. Haney and Pollitt (2011) model the degree of best practice incentive regulation, attempting to investigate the impact of industry size, political and economic institutions. This modelling approach may be equally instrumental in deciphering what impacts on the regulatory role in rail efficiency. Lastly, the gap between theoretical and practical aspects on international benchmarking is explored in Haney and Pollitt more recent work (2013). Factors that may obstruct regulators' capability of employing benchmarking techniques are here detailed, and future research may detect whether these factors affect rail regulatory experiences as well. Data requirements, choice of variables and sophistication of the benchmarking methodology may be among the factors that potentially push rail regulators towards adopting softer approaches, such as regulation discretion, which may be deemed as more incisive in satisfying regulatory purposes. Overall, this set of works on a comparable network industry allows to ascertain how certain regulatory areas are somewhat unexplored in railway studies. At the same time, these works highlight the importance of producing cross-comparisons between railway systems in future research. By comparatively examining rail regulation across systems, best practices will be pinpointed and deficiencies will be assessed, fostering the research path pursued by this thesis.

8.5 Policy implications

This final section discusses the main insights emerging from the qualitative and quantitative analyses reported in the previous chapters. Building on the questionnaire responses and the econometric estimates, policy implications will be drawn for both analyses, also attempting to provide linkages between them.

Starting from the questionnaire responses, a clear pattern seems to connect most of European rail regulators. Formal requirements involving the independence from political influence, and the necessary autonomy given by appropriate financial and human resources, except for a few contexts, appear to be met. This noticeable achievement is accompanied by high regulatory transparency levels and a generalised perception of stability and commitment in the industry. Significantly, these are features that not only reflect what was recommended by the literature on the ideal rail regulator characteristics, but also represents positive aspects that need to be nourished in future, strengthening existing configurations and resolving thorny issues in delayed systems. It seems that the European Commission intention of establishing an impartial and accountable third party in the national rail markets has been fulfilled in most of the countries analysed, where these bodies have emerged particularly in recent times.

Operationally, a more problematic scenario seems to arise. While the promptness of the regulators is generally commended by the set of regulatees, leading to actions able to tackle discriminatory practices, this constitutes only one side of the range of functions that European regulators are required and should be equipped to perform in the rail industry. This type of interventions, classed as indirectly producing beneficial effects on the level of costs, needs to be combined with direct activities targeting and pressuring the infrastructure managers. In reality, a handful of regulators are involved in the approval of all track access charging schemes, and even fewer regulators actually regulate the performance and efficiency of the network managers. As a matter of fact, in the majority of the countries surveyed, these regulatory powers may be argued to be at best partial or hesitant. Unfortunately, in this area the normative desiderata suggested by the Recast are not fully realised yet. Granting independence and destining resources to bodies that, except for a few advanced cases, are almost exclusively concerned with discriminatory practices does not seem to exploit the full regulatory potential. Relevantly, this thesis has attempted to point out that the efforts towards minimising railway costs should be

supported by the implementation of strong economic regulation, as the econometric evidence documents.

Looking firstly at the model selection, the econometric results (presented in Chapter 7) have highlighted the preference for the models based on disaggregated train km (Cases 3 and 6). In particular, the richer specification given by the emergence of the role played by passenger competition provides Case 6 with the edge.

The implications of the results in Case 6 attest that vertical separation and regulation are both needed in order to bring beneficial impacts in the form of cost reductions. To understand this finding, it is important to consider what occurs when the two reforms are not associated. On the one hand, strong economic regulation combined with the holding company (or vertical integration models), may not always be able to decipher the potentially discriminatory web of inner connections characterising these contexts. On the other hand, albeit without evidence, it seems reasonable to presume that vertical separation, in the absence of a strong economic regulator, may increase inefficiency due to transaction or misalignment costs, and because separated actors are not pressurised on efficiency to the same extent they would be with holding company or vertical integration. In partially or fully integrated structures, competitive pressure impacts on the firm as a whole, thus also pressuring the infrastructure division of the integrated structure. Therefore, in vertically separated contexts, strong regulation may guarantee that necessary pressure on the efficiency of infrastructure managers that railway operators are not able to exert. In sum, both vertical separation and regulation seem to function better when associated, as the results show. As a caveat, it should be noted that only a few regulators directly act or have the powers to request data on the efficiency levels of infrastructure managers. The beneficial role played by regulators in vertically separated contexts may therefore be associated primarily in the increase in operational transparency, leading to costs reduction and potentially enabling competition (though this effect may be captured by the competition variables in the models presented).

Given the findings of Mizutani and Uranishi (2013) and Mizutani et al. (2014), the overall effect of the interaction between vertical separation and regulation needs to be carefully considered in respect to the level of traffic density, which represents a detrimental factor in terms of railway costs. These previous studies computed specific density cut-off points, beyond which vertical separation stops producing beneficial effects on efficiency. In

this study, this critical level of density has been identified according to three different strengths of regulation (at its minimum, mean and maximum values), all combined with vertical separation: graphically, Figure 8.1 includes the three curves derived. In situations where regulation is weak (minimum value), vertical separation reduces costs when density is approximately below 0.38 times its average level (corresponding to just 26 data points). Increasing the strength of regulation to its mean value brings this critical value up to 1.06 times (which is the case for 68 observations). Further intensification of regulation (maximum value) augments the critical value for density (approximately below 1.29 times its average level) and involves 98 observations. Mizutani and Uranishi (2013) and Mizutani et al. (2014) find critical values for density equal to, respectively, 1.5-1.9 and 0.99 times the sample mean. The findings suggest that at mean levels regulation does not significantly alter the scenario in comparison with Mizutani et al. (2014), while a more powerful regulator, together with vertical separation, may greatly contribute to reduce costs for a wider range of density levels.

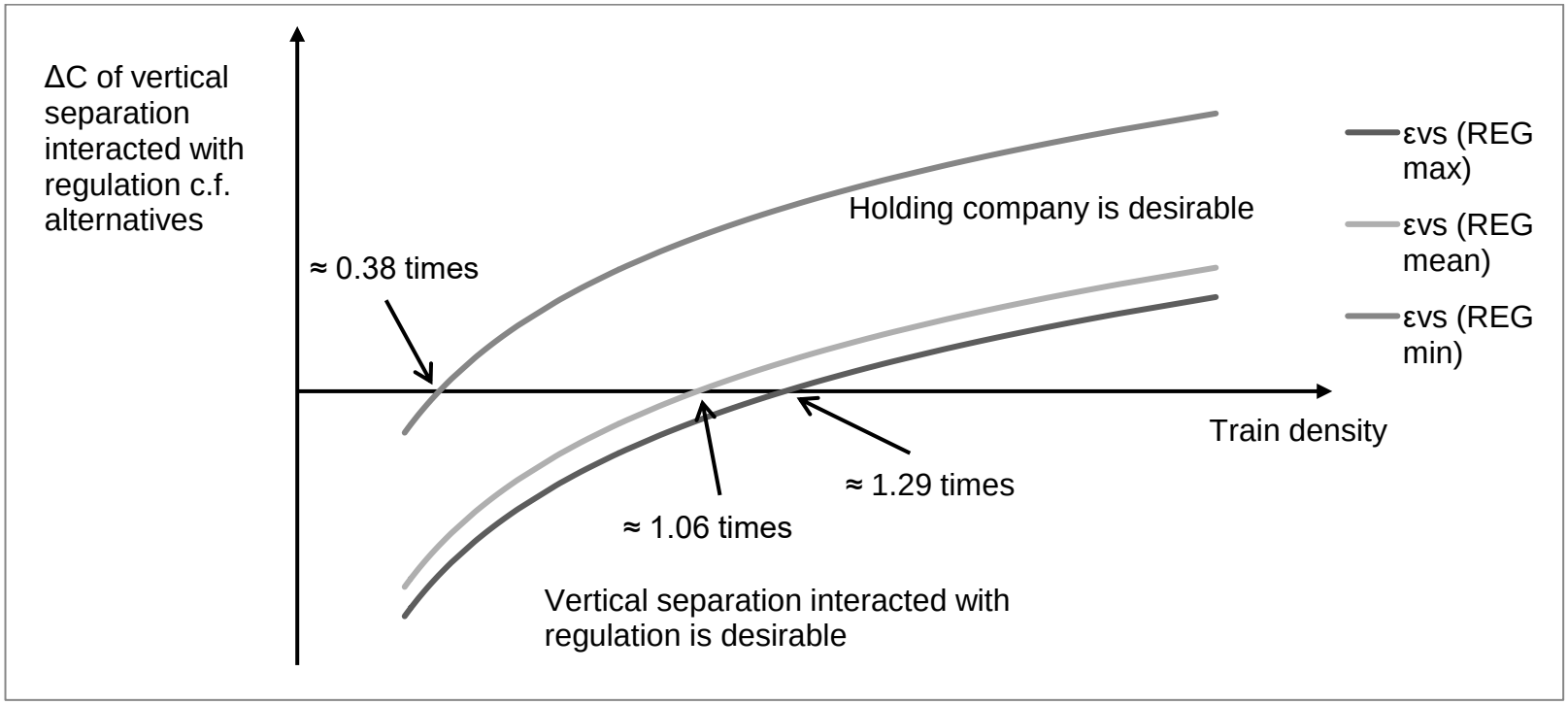

Figure 8.1 Cost difference between vertical separation - interacted with minimum, mean and maximum levels of regulation - and holding company, and its relationship with train density

Source: Author analysis based on the econometric estimations.

Important linkages between the qualitative and quantitative analyses can here be traced. Considering the econometric implications, investing in stronger economic regulation would be beneficial in terms of efficiency, and the way to carry this out is suggested by observing the regulation index scores and the questionnaire responses. In particular, enlarging the width of functions assigned to regulators, and tackling current deficiencies, as envisaged by the Recast, may play a part. The identification of these critical sub-drivers, attempted in the next paragraphs, is led by the following questions:

i. For which sub-drivers should investment in regulation yield more returns across the sample and the period of interest?
ii. What are the determinants of a good regulatory performance? And how did these change across the interval considered?
iii. Which sub-drivers were most crucial for those systems enjoying higher increases in their regulation index scores?

i. The sub-drivers wherein a regulatory investment is potentially more fruitful may be detected analysing the individual railway systems' performances in relation to the various sub-drivers of the regulation index. Thus, two lists of critical sub-drivers have been extrapolated, potentially able to identify where the most (or least) performing systems manifest their strength (or weakness). Reasonably, both consolidating these sources of strength and intervening in these sources of weakness can be judged as necessary and enhancing actions. These two types of sub-drivers were traced by verifying how common they are across the period considered by the IBM Rail Liberalisation Index reports (IBM and Kirchner, 2002, 2004, 2007 and 2011). In particular, the strength of highly performing railway systems appears to mainly lie on:

- The regulator's achieved independence of political influence;
- Large regulatory powers of investigation on network statement, allocation procedure, charging scheme, user fees and competition;
- The independence and transparency of the body issuing licences;
- The possibility of formalising framework contracts;
- The existence of a clearly designed, standardised and publicly available infrastructure charging system.

On the other hand, the following sub-drivers appear to appropriately represent the major sources of weakness for lowly performing railway systems:

- The regulatory lack of adoptable coercive means and legal certainty for ex-ante decisions;
- The regulator's limited capability to undertake investigations ex officio;
- Frail preservation of non-discriminatory access to services;
- Train path allocation processes scarcely transparent and standardised.

ii. Besides listing the most common sub-drivers in terms of regulatory strength and weakness, further main regulatory determinants (or, in other words, sub-drivers) have been studied more in depth, in order to ascertain what drove towards a high regulation index score at the beginning and at the end of the interval. This has been carried out by analysing the snapshots in European railway regulation in 2002 and in 2011. In terms of the general aspects of the regulatory body, in 2002 a strong performance was usually driven by the transparency of its competence, the independence of political influence and the existence of an annual report. By 2011, two extra sub-drivers elevated to the role of determinants. On the one hand, the existence of a regulatory authority pursuant to the First Railway Package, and therefore responsible for non-discriminatory access; its presence was traceable only in some countries in 2002, and became fully widespread in 2011. On the other hand, the regulatory transparency in case of proceedings and sanctions.

Instead, no changes have been identified when looking at the object of regulation: the possibility of investigating on network statement, allocation procedure, charging scheme, user fees and monitoring competition were deemed to be crucial for a good regulation index score both in 2002 and 2011.

In relation to the regulatory powers, common determinants in 2002 and 2011 were centred on the formalisation of regulatory decisions. Both in 2002 and 2011, in order to reach stronger regulatory performances, decisions should have had legally binding character, been able to be valid both ex-ante and ex-post, monitored in terms of both their processes and results, and informed with responsibility and rail expertise situated under one roof. Differences between the temporal extremities of this period

nevertheless arise: in 2011, the duty of starting investigations was not deemed as significant anymore, while relying on the legal certainty of ex-ante decisions became a crucial sub-driver.

Not many differences emerge when looking at the so-called administrative barriers, concerning the issue of licences and safety certificates, and the homologation of vehicles. The independence of the body (or bodies) issuing these documents, together with transparency of the related processes, greatly helped in obtaining a high regulation index score in 2011. Only the transparency of the process involving the homologation of vehicles did not seem to be able to offer analogous contribution in the 2002 situation.

Similarly, only one sub-driver differentiates the lists of determinants in 2002 and 2011 in relation to the train path access conditions. While transparent and standardised train path allocation processes were not considered decisive in 2002, they so became in 2011. The other determinants were represented, in both years, by the preservation of non-discriminatory access to services, transparent mechanisms to resolve conflicts, the possibility of formalising framework contracts and the absence of priority regulations for certain railway undertakings.

Further, identical determinants inherent in the infrastructure charging system are observable. The clarity of the scope justifying how the charges are levied, along with their standardisation and publication, strongly led to achieve a high regulatory score both in 2002 and 2011.

iii. Moving to the next question, the focus has here been placed onto another list of critical sub-drivers, which specifically characterise the most accentuated increases in the regulation index scores. Thus, those railway systems which benefitted from an overall score increase greater than 100%[49] (in the 2002-2011 period) have been investigated, determining that their enhancements were mostly driven by:

- The introduction of a regulatory authority responsible for non-discriminatory access, as well as the increased transparency of its competence;

[49] These strongly enhanced railway systems are Luxembourg (+369.56%), Greece (+146.39%), Ireland (+123.34%) and Norway (+100.87%). In 2002, these systems had regulation index scores which corresponded to either “delayed” or “pending departure” scenarios.

- Greater powers of investigation on user fees and competition;
- Improving the level of transparency of the body issuing safety certificates;
- Within the train path access conditions, the high transparency and standardisation of path allocation processes, the possibility of formalising framework contracts and the absence of priority regulations for certain railway undertakings;
- Ensuring a standardised and public infrastructure charging system.

Building on these analyses, it could be reasonably argued that providing regulators with stronger powers in these specific areas may yield better regulatory performances and, in turn, higher benefits in terms of system efficiency. In particular, by looking at these areas, there seems to emerge the necessity to tackle deficiencies and consolidate good practices especially in monitoring and investigative functions. This view is corroborated by the responses to the questionnaire reporting more recent and detailed information. Therein emphasis is placed onto tackling the following specific matters, which in almost all contexts require improvements:

- Tendering procedures are rarely implemented for the allocation of passenger routes covered by public service contracts and, where implemented, regulators only in isolated cases seem to be asked to collaborate on the designing stages;
- The growing diffusion of regulatory boards, as opposed to individual regulators, is to be encouraged for the purpose of benefitting from more shared and better founded decisional processes;
- In view of the growing liberalisation of rail markets across Europe, the increasing trend in human and financial resources available to regulators needs impulse;
- Annual reports, which are designed to consolidate the transparency and accountability of regulators, are scarcely produced and inadequately monitored;
- Track access charging schemes are approved by only a small number of regulators around Europe, even though regulators' response seem strong in case of appeals;
- Similarly, regulators' role is limited in relation to monitoring and enforcing the infrastructure manager's quality and efficiency;

- Access to infrastructure manager’s data on cost-efficiency and quality is allowed to only a few regulators.

Counter-arguments may justify some of these deficiencies. Utilising direct awards instead of tendering procedures may be determined by the lack of competitive forces, budgetary constraints may limit the allocation of more resources to regulatory operations, and the control of the infrastructure managers’ activities may be ensured by the presence of multi-annual contracts between these bodies and governments. Indeed, the Recast leaves the decision with the Member States on whether the regulatory body or the government is responsible for exerting pressure to reduce costs. Nonetheless, the empirical results of this work importantly attest that strong regulation, even in the face of great levels of density, positively impacts on efficiency. As explained previously, strengthening regulation implies intervening in specific areas, highlighted by the analyses on the results of the regulation index and on the responses to the questionnaire. Various strategies may be therefore delineated in order to foster this role. Gains in efficiency may arise from reshuffling railway governance arrangements: governments seem to play a strong role in many contexts where instead regulatory bodies’ expertise may be exploited. Regulatory intervention may be enhanced for the promotion of competition, beyond the current activities on non-discrimination and towards the designing of tenders. Moreover, enforcement of efficient practices on the part of the infrastructure managers may be pursued, carefully avoiding duplications with safeguarding mechanisms already envisaged by the multi-annual contracts. However, there would still appear to be advantages in having the role of incentivising and enforcing efficiency improvements played by a body that is independent of government, and this approach is generally adopted in economic regulation in the United Kingdom, for example.

The emerging story is not a simple one, but positive effects from regulation arise. Regulation seems to have beneficial effects on railway efficiency, particularly when associated with vertical separation, when below average levels of density exist, and when employed as instrumental to the creation of competitive practices (in the passenger sector in particular). Therefore, the decision on whether or when to introduce or strengthen regulatory powers seems to be dependent on a certain degree of market openness, a certain extent of structural unbundling, and a certain level of traffic. Even though some patterns can be detected across Europe, particularly related to the full attainment of formal requirements by the regulators, variegated

scenarios emerge and do not allow to indicate general policies valid for all the countries. Therefore, careful considerations need to be formulated when deciding on the appropriate regulatory framework, in order to avoid the risk of late or overcompensating interventions.

While national characteristics seem to determine the strength of the role played by regulators, there however exists a need of advancement and harmonisation in terms of measuring this role. The qualitative and quantitative analyses presented in this work have attempted to shed some light on this somewhat unexplored area in railways. In this sense, conferring more powers on regulators may not only benefit the systems' efficiency as shown, but also stimulate the design of much required international benchmarking activities in this industry. Comparable methods of monitoring efficiency and continental best practices would then be able to be employed, along the lines of what emerged in other network sectors (typically energy).

In summary, the main policy implications of this research are:

1) Strong economic regulation may lead to benefits in efficiency, but its effectiveness depends on specific railway systems' characteristics, involving the structure, competition and network density;

2) Following from the above point, not general but only system-based regulatory recommendations can be formulated. Corroborating this consideration are the questionnaire findings, accounting for variegated European rail regulatory scenarios;

3) Rail regulatory patterns at European level are markedly identifiable in terms of formal features involving, among the others, the almost ubiquitous presence of independent and autonomous regulators. Instead, at a more operational level, there does not exist a unique approach, as the current rail regulatory activities and powers seem to substantially differ across Europe in terms of ranges and extents;

4) Railway governances should be moulded according to a bottom-up approach, in conformity with a particular system's conditions. Importantly, in terms of economic regulation and regulator's role, what works in a context may not work in another, similarly to the findings highlighted by the literature on railway structural reforms (Mizutani et al., 2014);

5) Therefore, learning from the debate on other reforms, European legislation seems to better impact when focusing on designing a clear set of general requirements to be met by the individual countries. When

instead specific powers are granted, the particular characteristics of the individual systems may represent a burden for the success of European reforms. This may occur for various reasons. For instance, when regulators play a limited role within the railway governance of a particular country because other bodies already deal with certain regulatory activities, or when national markets are not attractive enough to incentivise the entrance of new competitors. The different paces of development characterising the European railway systems should then be borne in mind when legislating, in order to avoid promulgating seemingly necessary but practically untimely measures.

6) Following the direction undertaken by the Recast, enlarging the width of functions assigned to rail regulators is much required, if the aim of attaining more efficient and qualitatively satisfactory European railway systems is to be realised.

In conclusion, this research aimed to enhance the discussion on the impacts of economic regulation and the regulators' role in European railways. As noted previously, the undertaken path is yet to be completed, but this study importantly represents one of the first attempts able to give account of the critical interrelationships existing between the structure, competition and regulation which are and will be shaping European railway systems.

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List of Abbreviations

ACM	Autoriteit Consument & Markt / Authority for Consumers & Markets (Netherlands)
AIC	Akaike Information Criterion
AKOS	Agencija za Komunikacijska Omrežja in storitve Republike Slovenije (Slovenia)
AMT	Autoridade da Mobilidade e dos Transportes (Portugal)
ARAFER	Autorité de Régulation des Activités Ferroviaires et Routières (France)
ART	Autorità di Regolazione dei Trasporti / Transport Regulation Authority (Italy)
BDK	Banedanmark (Denmark)
BIC	Bayesian Information Criterion
BLS	Bern–Lötschberg–Simplon (Switzerland)
CER	Community of European Railway and Infrastructure Companies
CFL	Société Nationale des Chemins de Fer Luxembourgeois (Luxembourg)
CIE	Córas Iompair Éireann (Ireland)
CNMC	Comisión Nacional del Mercado y la Competencia (Spain)
CP	Caminhos de Ferro Portugueses (Portugal)
DB	Deutsche Bahn (Germany)
DSB	Danske Statsbaner (Denmark)
EC	European Commission
EEA	European Economic Area
EEC	European Economic Community
EU	European Union
FS	Ferrovie dello Stato Italiane (Italy)
GDP	Gross Domestic Product

IEA	International Energy Agency
ILR	Institut Luxembourgeois de Régulation (Luxembourg)
IRG	Independent Regulators' Group – Rail
ITF	International Transport Forum
KM	Kilometre
MJ	Megajoule
NMBS / SNCB	Nationale Maatschappij der Belgische Spoorwegen / Société Nationale des Chemins de fer Belges (Belgium)
NS	Nederlandse Spoorwegen (Netherlands)
NSB	Norges Statsbaner (Norway)
ÖBB	Österreichische Bundesbahnen (Austria)
OECD	Organisation for Economic Co-operation and Development
ORR	Office of Rail and Road (United Kingdom)
OSE	Hellenic Railways Organization (Greece)
PKP	Polskie Koleje Państwowe (Poland)
RACO / SKE	Railways Arbitration Commission /Schiedskommission im Eisenbahnver (Switzerland)
RAS	Regulatory Authority for Railways (Greece)
RENFE	Red Nacional de los Ferrocarriles Españoles (Spain)
RU	Railway Undertaking
SBB / CFF / FFS	Schweizerische Bundesbahnen / Chemins de fer Fédéraux Suisses / Ferrovie Federali Svizzere (Switzerland)
SNCF	Société Nationale des Chemins de fer Français (France)
SJ	Statens Järnvägar (Sweden)
SJT	Statens Jernbanetilsyn / Norwegian Regulatory Authority (Norway)
SUR	Seemingly Unrelated regressions

TOC	Train Operating Companies (United Kingdom)
TOE	Tonnes of Oil Equivalent
TRAFI	Liikenteen Turvallisuusvirasto / Finnish Transport Safety Agency (Finland)
VR	Valtion Rautatiet (Finland)
UIC	Union Internationale des Chemins de fer / International Union of Railways
UTK	Urząd Transportu Kolejowego / Office for Rail Transport (Poland)

Appendix A
Summary of findings from literature on the impacts of railway reforms

This appendix will summarise the findings emerged from the literature on the impacts of railway reforms (Chapter 2) by focusing on the following main aspects:

- The sign and magnitude of the impacts of specific reforms, such as vertical and horizontal separation, open access, accounting separation and presence of an independent regulator;
- The limitations affecting the studies, together with reflections and further developments arising from the results.

Table A.1 will illustrate the former aspects, while Table A.2 will describe the latter. The order the studies are listed follows the way they are presented in the literature review in Chapter 2.

Table A.1 Summary of findings on impacts of specific railway reforms

Paper	Impacts				
	Vertical separation	**Horizontal separation**	**Open access**	**Accounting separation**	**Independent regulator**
Mizutani and Uranishi (2013)	Positive when train density is low	Positive			
van de Velde et al. (2012)	Adversely influenced by high train density and freight traffic's share	Positive	Insignificant		
Mizutani et al. (2014)	Positive when train density is low	Positive	Insignificant		
Cantos et al. (2011)	Positive with openness of freight market and horizontal separation	Positive with vertical separation, high influence	• Positive for freight market with vertical separation • Scarce influence of tendering procedures		

Paper	Impacts				
	Vertical separation	**Horizontal separation**	**Open access**	**Accounting separation**	**Independent regulator**
Cantos et al. (2012)	Positive with horizontal separation, low influence	Positive with vertical separation	Positive for passenger and freight services, high influence		
Friebel et al. (2010)	Positive if full package implemented gradually	Positive if full package implemented gradually	Positive if full package implemented gradually		Positive if full package implemented gradually
Wetzel (2008)	• Positive for domestic freight sector • Negative for international and domestic passenger markets		Positive		
Asmild et al. (2009)			Positive		

Paper	Impacts				
	Vertical separation	**Horizontal separation**	**Open access**	**Accounting separation**	**Independent regulator**
Growitsch and Wetzel (2009)	Negative for most countries analysed				
Jensen and Stelling (2007)	Negative		Positive		
Merkert et al. (2012)	Slightly negative				
Merkert (2012)	Increase in transaction costs, but not to a large extent				
Drew and Nash (2011)	Worse than integrated form				

Paper	Impacts				
	Vertical separation	**Horizontal separation**	**Open access**	**Accounting separation**	**Independent regulator**
Preston and Robins (2013)	Negative effects on welfare	Negative effects on welfare			
Drew (2009)	Better than open access to freight services		Worse than vertical separation (for freight market)		

Table A.2 Remarks on studies from literature on impacts of railway reforms

Paper	Remarks	
	Limitations	**Reflections and further developments**
Mizutani and Uranishi (2013)	• Exclusion of United Kingdom, United States, Canada, Australia and Mexico	• Investigation of numerous typologies of vertical separation enforced • Indirect effects of general competitive conditions
van de Velde et al. (2012)	• Competition effects appear not to be considered fully in their impact • Freight competition dummy is not sub-clustered into different sub-dummies (as it is for passenger competition) due to lack of data	• United Kingdom was included in the sample, tackling the limitation of previous studies • Accurate information on the temporal implementation of the reforms was collected • Two further organisational intermediate models are included in the analysis: holding company and separation of essential functions (within a bundled or vertically unbundled configuration) • Reduction of costs produced by horizontal separation may be partly reflected by the sale of freight undertakings, therefore accounting for benefits not directly related to this type of unbundling

Paper	Remarks	
	Limitations	**Reflections and further developments**
Mizutani et al. (2014)		• Inclusion of holding company represents a novelty in the literature • Differences in individual railway systems call for multiple recipes in terms of organisational choice
Cantos et al. (2011)	• Difficulties in dividing the effects of reforms.	• Better results in terms of efficiency, technical progress and productivity for countries which undertook a full process of separation • Introduction of vertical separation is positive when accompanied by implementation of horizontal separation
Cantos et al. (2012)		• Dummy for implementation of full package shows the significance of complementarities gained thanks to interactions between different measures

Paper	Remarks	
	Limitations	**Reflections and further developments**
Friebel et al. (2010)	• Absence of relevant indications regarding the effects of individual reforms • British data not complete and not considered for most of the regressions in the study • Reforms are measured on the basis of their formal legislative approval, rather than actual enforcement • Intensity of subsidisation across countries and potential impacts of qualitative factors are not illustrated	• Simultaneous application of reforms might bring about negative performances
Wetzel (2008)	• Partial or total exclusion of United Kingdom, Denmark, the Netherlands, Sweden and Estonia • Temporal discrepancy between legislative promulgation of regulations and their concrete enforcement	• Unsatisfactory outcome may be produced by the incomplete implementation of reforming package

Paper	Remarks	
	Limitations	**Reflections and further developments**
Asmild et al. (2009)	• Data were unavailable for Bulgaria, Latvia, Lithuania and Romania which were therefore not included in the sample • Strong econometric assumption in connection with efficiency, considering relative changeovers only due to legislative innovations	• Distinction of the effects deriving from accounting and complete separation, underscoring the importance of examining their isolated contribution on the improvement of railway systems
Growitsch and Wetzel (2009)	• Privatisation, competitive experience and rail modal share should be assessed	• Most of analysed European countries show economies of scope • Further paths may be able to detect the direction of the impacts of economies of scope (vertical or horizontal) and explore railway quality and safety effects on costs
Jensen and Stelling (2007)	• Cost data for some new small operators were not obtainable and, in case an approximation was not feasible, discarded	• Importance of certain sources that might exert a positive influence on efficiency, describing the significance of deregulation interventions as contributing for a percentage between 50% and 60% of the costs reduction

Paper	Remarks	
	Limitations	**Reflections and further developments**
Merkert et al. (2012)	• Some operators' data unavailable, but sample is considered to be adequately representative of the countries' systems • Bottom-up process unable to take into account different interfaces, as well as to distinguish the costs for operations of monitoring of performances from specific interconnections between the network managers and the railway companies	• Further strands suggested on wider identification of the effects of vertical separation on the overall efficiency levels, as well as on appropriate detection of the advantages from incentivising competition • Transaction costs should be monitored at regular intervals in order to verify whether noteworthy modifications have occurred

Paper	Remarks	
	Limitations	**Reflections and further developments**
Merkert (2012)	• Limits on labour measurement, with only potential capacity (and not realised capacity) assessed, resulting in overestimation of the transaction costs • Difficulties in determining the parent support and the transaction costs related to the whole system	• Low transaction costs for railway undertakings in comparison with total operating costs (on average at about 10% at firm level) • Better results for German holding model, even though parent support and revealed scale should be considered in the comparison with other railway systems • Even little vertical separation and competition effects may counter transaction costs • Supplementary research needed on the actual impact of labour on transaction costs, the interrelations between network manager and rail operator, the characteristics of the decision-making process, and the evaluation of further typologies of cost

Paper	Remarks	
	Limitations	**Reflections and further developments**
Drew and Nash (2011)		• The regulation environment, the financial conditions of the incumbent, the presence of services of public interest, as well as the governmental support in infrastructure interventions, should be taken into consideration • Identification of isolated effects of vertical separation
Preston and Robins (2013)	• The counterfactual employed in the work does not take account of increasing costs in infrastructure after privatisation and, above all, Hatfield accident	• Welfare outcomes declined after Hatfield accident (2000), when public control on network manager and rail operators became stricter • Reforms increased complexity of the system, producing a rise in costs (transaction costs, diseconomies of scale and principal-agent-related costs) • Regulation failures are pointed out in respect to low level of investments in infrastructure

Paper	Remarks	
	Limitations	**Reflections and further developments**
Drew (2009)		• British study highlights how vertical separation might induce a rise in infrastructure and transaction costs • Railway reforms are linked to institutional, market sub-divisions, scale, scope and technical characteristics, configuring a multi-faced scenario where these aspects may change within the same country

Appendix B
Rail regulation questionnaire for regulators

I. POSITIONING IN THE MARKET		
Purpose: Understanding the historical evolution of the regulator, as well as the competition levels of passenger sub-markets		
A) General information about the regulator		
1)	When was the regulator set up?	
2)	What have been the major changes in regulatory responsibilities since 2002, and in which year did they occur?	
B) Open access and public contract services		
1a)	What is the proportion of the passenger market covered by public service obligations? (in % of passenger-kilometres)	
1b)	What proportion of these routes under public service contracts (as per question 1a) is allocated through direct awards and competitive tendering, respectively? (in % for passenger-kilometres)	
2a)	Is competition legally permitted in the non-public service contracts domestic market? (exclude cases where international services compete with domestic services) [Yes / Partly / No]	
2b)	Does it happen in practice? [Yes / No]	
Comments:		

II. STABILITY AND PREDICTABILITY OF THE REGULATORY BODY		
Purpose: Delineating whether the interaction with political bodies may affect the regulator's autonomy		
A) Terms of appointment		
1)	Are decisions by regulatory body made by a regulatory board as opposed to an individual regulator?	
2a)	Is the board appointed for a fixed term? (Where there is no board, please answer these questions in respect to the appointment of the regulator) [Yes / No]	
2b)	If yes, how long is it? (in years)	
3a)	Can the members of the board be re-appointed? [Yes / No]	
3b)	If yes, how many times?	
B) Board's structure		
1)	How many persons are appointed to the board? And how many are employed full-time and part-time?	
2)	How does the regulator's board formalise its decisions? [By majority voting / Unanimity / Other]	
3)	How is the board appointed? [By the Government / By the board itself / Other]	
4a)	Is the regulatory body required to take into account Government guidance with respect to its regulatory decisions? [Yes / Partly / No]	
4b)	Please give examples if relevant	
Comments:		

III. NON-DISCRIMINATION		
Purpose: Identification of the extent to which operators can get fair access to the infrastructure		
A) Access to train paths and services		
1)	How many complaints are received and dealt with by the regulator? (on average in a one-year period)	
2a)	Are certain RUs favoured when disruptions affect the allocation of train paths, the access to services and the timetabling process? [Yes / No]	
2b)	If yes, which operators and why?	
B) Proportion of capacity to be allocated through multi-annual agreements		
1a)	What proportion of infrastructure capacity is allocated through multi-annual agreements? (in %)	
1b)	With which operators?	
Comments:		

IV. PRESENCE OF APPROPRIATE HUMAN AND FINANCIAL RESOURCES		
Purpose: Verifying whether the regulator is sufficiently equipped in order to develop and achieve its tasks and objectives		
A) Consistency between requirements and available resources		
1)	How many employees in terms of full-time equivalent are currently working for the authority on railway economic regulations (i.e. excluding safety and interoperability)?	
2)	What is the main background of the employees working exclusively on railway economic regulations? [Rail industry / Economic / Legal / Other]	
3a)	Does the regulator have adequate financial resources for the tasks required? [Yes / No]	
3b)	If no, please explain the reasons	
B) Source of financial resources		
1a)	Are the regulatory authority's operations funded by the government and/or by the industry? [Only by Government / Only by Industry / By Government and Industry / Other]	
1b)	And in what proportion?	
2)	Are the funders represented on the regulatory authority's board? [Yes / No]	
Comments:		

V. PRO-ACTIVITY AND EFFECTIVENESS		
Purpose: Detection of autonomous powers for analysis, interventions and effectiveness		
A) Obligation to start investigations		
1)	Do all track access charging schemes have to be submitted to the regulator for approval? [Yes / No]	
B) Legally and financially binding decision-power		
1a)	Are the decisions of the regulatory body advisory or legally binding? [Advisory / Legally binding]	
1b)	Can those affected by these decisions appeal? If yes, who to?	
2a)	Does the regulatory authority have the possibility of enforcing penalties such as fines? [Yes / No]	
2b)	What penalties can be imposed? And how large may they be?	
Comments:		

VI. DATA ON EFFICIENCY AND MULTI-ANNUAL CONTRACTS		
Purpose: To see what mechanisms are in place to achieve efficiency		
A) Monitoring of the Infrastructure Managers		
1)	Is a multi-annual contract involving the Infrastructure Manager and Government in place? [Yes /No]	
2)	To what extent is the performance and efficiency of the Infrastructure Manager regulated by Government through this contract as opposed to by the regulator?	
3)	Does the regulatory body have a role in monitoring and enforcing the quality and efficiency of the Infrastructure Manager? [Yes / No]	
3b)	If so, how is this undertaken?	
4)	Can the regulatory authority require provision of data on cost-efficiency and quality of service on the part of the Infrastructure Managers? [Yes / No]	
Comments:		

COMMENTS ON THE QUESTIONNAIRE
Potential improvements, corrections and suggestions
Please add here any further comments you may have:

Appendix C
Rail regulation questionnaire for infrastructure managers and railway undertakings

I. NON-DISCRIMINATION		
Purpose: Identification of the extent to which operators can get fair access to the infrastructure		
A) Access to infrastructure and services		
1)	For which of the following aspects is discrimination considered to be a problem? (multiple selection is possible) [Tracks / Rolling stock / Highly specialised staff / Use of electrical supply equipment for traction current / Refuelling facilities / Freight terminals / Marshalling yards / Train formation facilities / Storage sidings / Depots / Passenger stations / Other]	
2a)	Does the regulator tackle the related problems promptly and effectively? [Yes / No]	
2b)	If no, please provide more detail (for instance, specific cases)	
B) Proportion of capacity to be allocated through multi-annual agreements		
1a)	What proportion of infrastructure capacity is allocated through multi-annual agreements? (in %)	
1b)	With which operators?	
Comments:		

II. DISTINCTION BETWEEN RESPONSIBILITIES OF THE REGULATOR AND THE GOVERNMENT (OR OTHER AGENCIES)		
Purpose: Detecting overlapping of roles and accountability for regulator's choices and measures		
A) Dependence status of decision maker for licensing, safety certificates and homologation of vehicles		
1a)	Are connections existing between the RUs and the body (or bodies) issuing licences, safety certificates and vehicles certifications/permissions? [Yes / No]	
1b)	If yes, for which body (or bodies)?	
B) Government influence		
1a)	Is the regulatory body required to take into account Government guidance with respect to its regulatory decisions? [Yes / Partly / No]	
1b)	Please give examples if relevant	
2)	How is the independence of political influence ensured for the regulator?	
Comments:		

III. TRANSPARENCY		
Purpose: Identifying whether the regulator displays in a public way the process and the results that substantiate specific decisions		
A) Transparency of Regulatory Authority's competence and processes		
1a)	Are the regulatory body's roles, objectives, powers and processes publicly available and clearly specified? [Yes / No]	
1b)	If no, which areas need to be better specified?	
1c)	Where can the information in question 1a be traced?	
2)	Is the annual report (if existing) reviewed by impartial third parties? [Yes / No]	
B) Transparency for licensing, safety certificates and homologation of vehicles		
1a)	Are the decisional methods and processes of the relevant body (bodies) clearly specified and publicly available? [Yes / No]	
1b)	If no, which areas need to be better specified?	
1c)	Where can the information in question 1a be traced?	

III. TRANSPARENCY		
C) Transparency for the allocation processes and conflicts		
1a)	Are the allocation processes and decisions clearly specified and publicly available for all the interested RUs? [Yes / No]	
1b)	If no, which areas need to be better specified?	
1c)	Where can the information in question 1a be traced?	
2a)	In case of conflicts regarding allocation issues, are the related procedures for investigations clearly specified and publicly available for all the interested RUs? [Yes / No]	
2b)	If no, which areas need to be better specified?	
Comments:		

IV. PRO-ACTIVITY AND EFFECTIVENESS		
Purpose: Detection of autonomous powers for analysis, interventions and effectiveness		
A) Obligation to start investigations		
1)	Do all track access charging schemes have to be submitted to the regulator for approval? [Yes / No]	
Comments:		

V. DATA ON EFFICIENCY AND MULTI-ANNUAL CONTRACTS		
Purpose: To see what mechanisms are in place to achieve efficiency		
A) Monitoring of the Infrastructure Managers		
1)	Is a multi-annual contract involving the Infrastructure Manager and Government in place? [Yes /No]	
2)	To what extent is the performance and efficiency of the Infrastructure Manager regulated by Government through this contract as opposed to by the regulator?	
3)	Does the regulatory body have a role in monitoring and enforcing the quality and efficiency of the Infrastructure Manager? [Yes / No]	
3b)	If so, how is this undertaken?	
4)	Can the regulatory authority require provision of data on cost-efficiency and quality of service on the part of the Infrastructure Managers? [Yes / No]	
Comments:		

COMMENTS ON THE QUESTIONNAIRE
Potential improvements, corrections and suggestions
Please add here any further comments you may have:

Appendix D
Regulation index: range of answers

In this appendix the sub-drivers of the regulation index will be further investigated, presenting the respective ranges of answers employed by the authors of the 4 Rail Liberalisation Index reports (IBM and Kirchner, 2002, 2004, 2007 and 2011). As indicated in Section 6.2.1, the numeric range for all sub-drivers within the regulation index (and within the Rail Liberalisation Index) goes from 1 (minimum) to 10 (maximum). The specific meaning of each component of the scoring range will be detailed, as extrapolated from the above reports.

In particular, given that most sub-drivers prompt a score of either 1 or 10, two corresponding columns will be reported while the intermediate answers will be provided together in a separate column (with the score in bold and the related answer in brackets). Since not all the sub-drivers are included in all the reports (see Section 6.2.1), some information turn out to be unavailable, especially for the earliest reports, and the related cells have been greyed out accordingly. The exact names of the drivers and sub-drivers correspond to those adopted in the latest version of the report published in 2011 (IBM Deutschland GmbH and Kirchner, 2011).

Table D.1 Regulation index: range of answers from Rail Liberalisation Index 2002 report

Source: IBM Business Consulting Services and Kirchner (2002), pp.104-112

Driver	Sub-driver	1	10	Other answers
General Aspects of the Regulatory Authority				
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	No	Yes	
	Transparency of competence of Regulatory Authority	No	Yes	**5** (Partly)
	Transparency in case of proceedings/sanctions			
	Independence of political influence			
	Existence of an annual report			

Driver	Sub-driver	1	10	Other answers
Object of the Regulation				
	Inspection of network statement (10 aspects)	0-2	10+	**2** (3); **3** (4); **4** (5); **5** (6); **6** (7); **7** (8); **8** (9); **9** (10)
	Investigations concerning allocation procedure	No	Yes	
	Investigations concerning charging scheme	No	Yes	
	Investigations concerning level or structure of user fees	No	Yes	
	Monitoring competition	No	Yes	
Powers of the Regulatory Authority				
	Can/Must start investigations upon request[50]	No	Yes	

[50] Separate questions are employed in this report to ask whether the regulator “can” or “must” start investigations upon request.

Driver	Sub-driver	1	10	Other answers
	Can/Must start investigations ex officio[51]	No	Yes	
	Legally binding character of Regulatory Authority decisions	No	Yes	
	Determination by the regulatory body			
	Possibility of imposing coercive means	No	Yes	
	Possibility of imposing fines	No	Yes, major	**4** (Yes, minor)
	Possibility of issuing ex-post and/or ex-ante decisions			
	Legal certainty of ex-ante decisions			
	Monitoring processes	No	Yes	**5** (Partly)

[51] Separate questions are employed in this report to ask whether the regulator “can” or “must” start investigations ex officio.

Driver	Sub-driver	1	10	Other answers
Licensing				
	Independence of decision maker from incumbent	Dependent	Formally and factually independent	**3** (Formally independent)
	Transparency of licensing process			
Safety certificate				
	Independence of decision maker from incumbent	No	Formally and factually independent	**3** (Formally independent)
	Transparency of issue process	No	Yes, with documents available	**7** (Yes, but no documents available)
Homologation of Vehicles				
	Independence of decision maker from incumbent	No	Formally and factually independent	**3** (Formally independent)

Driver	Sub-driver	1	10	Other answers
	Transparency of the issuing process	No	Yes, with documents available	**7** (Yes, but no documents available)
Train Path Access Conditions				
	Existence of priority regulations for certain RUs[52]	Yes	No	**9** (By train type (if exclusivity of incumbent))
	Non-discriminatory access to services	No	Yes, with documents available	**7** (Yes, but no documents available)
	Non-discriminatory marketing for all train paths	No	Yes	**9** (Yes, but with socio-economic considerations)
	Transparent mechanism to resolve conflicts	No	Yes	**5** (Partly)
	Framework contracts	No	Yes	

[52] This sub-driver in the 2002 report focuses on “priority scheduling arrangements for the incumbent” (IBM Business Consulting Services and Kirchner, 2002, p.110).

Driver	Sub-driver	1	10	Other answers
	Transparent and standard train path allocation processes	No	Yes, with documents available	**7** (Yes, but no documents available)
Infrastructure Charging System				
	Coverage of infrastructure charging system	No	Yes	
	Publication of infrastructure charging system	No	Yes	**5** (Partly)
	Uniform charging system	No	Yes	

Table D.2 Regulation index: range of answers from Rail Liberalisation Index 2004 report

Source: IBM Business Consulting Services and Kirchner (2004), Annex VII. Weightings and range of answers

Driver	Sub-driver	1	10	Other answers
General Aspects of the Regulatory Authority				
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	No Regulatory Authority	Appropriate Regulatory Authority (as per Art.30 Directive 2001/14/EC)	**5** (A kind of Regulatory Authority); **7** (Several appropriate institutions)
	Transparency of competence of Regulatory Authority	No	Yes	**5** (Yes, but no documents)
	Transparency in case of proceedings/sanctions	No	Yes	**5** (Yes, but no documents)
	Independence of political influence			
	Existence of an annual report			

Driver	Sub-driver	1	10	Other answers
Object of the Regulation				
	Inspection of network statement (10 aspects)	No (0)	Yes (10)	**2** (Yes (1+2)); **3** (Yes (3)); **4** ((Yes (4)); **5** (Yes (5)); **6** (Yes (6)); **7** (Yes (7)); **8** (Yes (8)); **9** (Yes (9))
	Investigations concerning allocation procedure	No	Yes	
	Investigations concerning charging scheme	No	Yes	
	Investigations concerning level or structure of user fees	No	Yes	
	Monitoring competition			
Powers of the Regulatory Authority				
	Can/Must start investigations upon request	Neither nor	Must	**5** (Can)

Driver	Sub-driver	1	10	Other answers
	Can/Must start investigations ex officio	Neither nor	Must	**5** (Can)
	Legally binding character of Regulatory Authority decisions	No	Yes	
	Determination by the regulatory body			
	Possibility of imposing coercive means	No	Yes	
	Possibility of imposing fines	No	Yes, high	**4** (Yes, low)
	Possibility of issuing ex-post and/or ex-ante decisions			
	Legal certainty of ex-ante decisions			
	Monitoring processes			

Driver	Sub-driver	1	10	Other answers
Licensing				
	Independence of decision maker from incumbent	Dependent	Formally and de facto independent	**3** (Formally independent)
	Transparency of licensing process	No	Yes	**5** (Yes, no documents)
Safety certificate				
	Independence of decision maker from incumbent	No	Formally and de facto independent	**3** (Formally independent)
	Transparency of issue process	No	Yes	
Homologation of Vehicles				
	Independence of decision maker from incumbent	No	Formally and de facto independent	**3** (Formally independent)
	Transparency of the issuing process	No	Yes, with documents available	**7** (Yes, but no documents available)

Driver	Sub-driver	1	10	Other answers
Train Path Access Conditions				
	Existence of priority regulations for certain RUs	Yes	No	
	Non-discriminatory access to services[53]	No	Yes	**5** (Yes, no experiences)
	Non-discriminatory marketing for all train paths[54]	No	Yes, unsolicited	**6** (Yes, upon request)
		No	Yes, no restrictions	**5** (Yes, with restrictions)
	Transparent mechanism to resolve conflicts	No	Yes	**5** (Not clear)
	Framework contracts	No	Yes	

[53] This sub-driver comprises the responses to the following: “Processing of applications for the allocation of train paths”, “Right to use allocated train paths”, “Use of running train path points and junctions”, “Control of train (signals, regulation etc.)” and “Other essential information” (IBM Business Consulting Services and Kirchner, 2004, Annex VII. Weightings and range of answers, p.6).

[54] Marketing for all train paths is measured by two sub-drivers in the 2004 report: higher cells refer to “Recording and communicating of available train paths” and lower cells refer to “Provision of relevant train path information” (IBM Business Consulting Services and Kirchner, 2004, Annex VII. Weightings and range of answers, p.6).

Driver	Sub-driver	1	10	Other answers
	Transparent and standard train path allocation processes	No	Yes	
Infrastructure Charging System				
	Coverage of infrastructure charging system[55]	No	Yes	
	Publication of infrastructure charging system[56]	No	Yes	**4** (Unclear formula)
	Uniform charging system[57]	No	Yes	

[55] This sub-driver comprises the responses to the following: “Processing of applications for assignment of Train Path Price System”, “Right to use assigned Train Path Price System capacity”, “Use of turnouts and junctions”, “Train control”, “Provision of all other essential information” and “Use of utilities for traction current” (IBM Business Consulting Services and Kirchner, 2004, Annex VII. Weightings and range of answers, p.7).

[56] This sub-driver combines the responses related to both freight and passenger transport (IBM Business Consulting Services and Kirchner, 2004, Annex VII. Weightings and range of answers, p.7).

[57] This sub-driver combines the responses related to both freight and passenger transport (IBM Business Consulting Services and Kirchner, 2004, Annex VII. Weightings and range of answers, p.7).

Table D.3 Regulation index: range of answers from Rail Liberalisation Index 2007 report

Source: IBM Global Business Services and Kirchner (2007), Annex IV – Weightings and response scale

Driver	Sub-driver	1	10	Other answers
General Aspects of the Regulatory Authority				
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	No	Yes	
	Transparency of competence of Regulatory Authority	No	Yes, with documentation	**5** (Yes, but no documentation / only partly transparent)
	Transparency in case of proceedings/sanctions	No	Yes, with documentation	**5** (Yes, but no specific regulations)
	Independence of political influence	No, as political influence is potentially possible	Yes	

Driver	Sub-driver	1	10	Other answers
	Existence of an annual report	No	Yes, available to public	
Object of the Regulation				
	Inspection of network statement (10 aspects)	No	Yes (10 out of 10)	**2** (Yes (1, 2 out of 10)); **3** (Yes (3 out of 10)); **4** (Yes (4 out of 10)); **5** (Yes (5 out of 10)); **6** (Yes (6 out of 10)); **7** (Yes (7 out of 10)); **8** (Yes (8 out of 10)); **9** (Yes (9 out of 10))
	Investigations concerning allocation procedure	No	Yes	
	Investigations concerning charging scheme	No	Yes	
	Investigations concerning level or structure of user fee	No	Yes	
	Monitoring competition	No	Yes	

Driver	Sub-driver	1	10	Other answers
Powers of the Regulatory Authority				
	Can/Must start investigations upon request	Neither nor	Must	**5** (Can)
	Can/Must start investigations ex officio	Neither nor	Must	**5** (Can)
	Legally binding character of Regulatory Authority decisions	No	Yes, and objections have no suspensive effects	**3** (Yes, but objections have suspensive effect)
	Determination by the regulatory body	Responsibility for decisions and rail expertise are not under one roof	Responsibility for decisions and rail expertise are under one roof	
	Possibility of imposing coercive means	No	Yes, high	**3** (Yes, but no or few figures given); **5** (Yes, medium)

Driver	Sub-driver	1	10	Other answers
	Possibility of imposing fines	No	Yes, high	**3** (Yes, but no or few figures given); **5** (Yes, medium)
	Possibility of issuing ex-post and/or ex-ante decisions	Neither nor	Ex-ante possible	**4** (Only ex-post)
	Legal certainty of ex-ante decisions	No	Yes	**3** (No empirical values available)
	Monitoring processes	No	Both	**6** (Only the results); **8** (Processes only)
Licensing				
	Independence of decision maker from incumbent	Dependent	Formally and de facto independent	**3** (Formally independent)
	Transparency of licensing process	No	Yes, with documentation / positive experience	**3** (Negative experience); **5** (No documentation / no experience)

Driver	Sub-driver	1	10	Other answers
Safety certificate				
	Independence of decision maker from incumbent	No	Formally and de facto independent	**3** (Formally independent)
	Transparency of issue process	No	Yes, with documentation / positive experience	**3** (Negative experience); **5** (No documentation / no experience)
Homologation of Vehicles				
	Independence of decision maker from incumbent	No	Formally and de facto independent	**3** (Formally independent)
	Transparency of the issuing process	No	Yes, with documentation / positive experience	**3** (Only partially) **5** (No documentation)

Driver	Sub-driver	1	10	Other answers
Train Path Access Conditions				
	Existence of priority regulations for certain RUs	Yes	No	
	Non-discriminatory access to services[58]	No / Confirmation by Regulatory Authority in 2006/2007	Yes	**2** (Yes, but no empirical values); **5** (“Subjectively believed discrimination” (Not reported to Regulatory Authority / proceedings pending))
	Non-discriminatory marketing for all train paths[59]	No	Yes, voluntarily	**6** (Yes, only on request); **8** (Partially voluntarily / partially on request)
		No	Yes, no restrictions	**5** (Yes, with restrictions)

[58] This sub-driver combines the responses related to both freight and passenger transport in terms of the following: “Application for the allocation of train paths”, “Right to use allocated train paths”, “Use of points, switches and junctions”, “Train control” and “Other information” (IBM Global Business Services and Kirchner, 2007, Annex IV – Weightings and response scale, p.9).

[59] Marketing for all train paths is measured by two sub-drivers in the 2007 report: higher cells refer to “Recording and communication of available train paths” (combining responses related to both freight and passenger transport) and lower cells refer to “Provision

Driver	Sub-driver	1	10	Other answers
	Transparent mechanism to resolve conflicts[60]	No	Yes, documented	**5** (Yes, no documentation / partially)
	Framework contracts	No	Yes	
	Transparent and standard train path allocation processes[61]	No, not yet documented / not standardised	Yes, documented and harmonised	**4** (Partially)

of train path information relevant for the offer" (IBM Global Business Services and Kirchner, 2007, Annex IV – Weightings and response scale, p.10)

[60] This sub-driver combines the responses related to both freight and passenger transport (IBM Global Business Services and Kirchner, 2007, Annex IV – Weightings and response scale, p.10).

[61] This sub-driver combines the responses related to both freight and passenger transport (IBM Global Business Services and Kirchner, 2007, Annex IV – Weightings and response scale, p.10).

Driver	Sub-driver	1	10	Other answers
Infrastructure Charging System				
	Coverage of infrastructure charging system[62]	No	Yes	
	Publication of infrastructure charging system[63]	No	Yes	
	Uniform charging system[64]	No	Yes	

[62] This sub-driver comprises the responses to the following: “Application for the allocation of train paths”, “Right to use allocated train paths”, “Use of points, switches and junctions”, “Train control”, “Provision of other information” and “Use of utilities for traction current supply” (IBM Global Business Services and Kirchner, 2007, Annex IV – Weightings and response scale, p.11).

[63] This sub-driver combines the responses related to both freight and passenger transport (IBM Global Business Services and Kirchner, 2007, Annex IV – Weightings and response scale, p.11).

[64] This sub-driver combines the responses related to both freight and passenger transport (IBM Global Business Services and Kirchner, 2007, Annex IV – Weightings and response scale, p.11).

Table D.4 Regulation index: range of answers from Rail Liberalisation Index 2011 report

Source: IBM Deutschland GmbH and Kirchner, 2011, Annex IV – Weightings and range of answers

Driver	Sub-driver	1	10	Other answers
General Aspects of the Regulatory Authority				
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	No	Yes	
	Transparency of competence of Regulatory Authority	No	Yes, with documentation	**5** (Yes, but without documentation / only partly transparent)
	Transparency in case of proceedings/sanctions	No	Yes, with documentation	**5** (Yes, but not specified)
	Independence of political influence	No, political influence potentially possible	Yes	

Driver	Sub-driver	1	10	Other answers
	Existence of an annual report	No	Yes, public	
Object of the Regulation				
	Inspection of network statement (10 aspects)	No	Yes (10 of 10)	**2** (Yes (1, 2 of 10)); **3** (Yes (3 of 10)); **4** (Yes (4 of 10)); **5** (Yes (5 of 10)); **6** (Yes (6 of 10)); **7** (Yes (7 of 10)); **8** (Yes (8 of 10)); **9** (Yes (9 out of 10))
	Investigations concerning allocation procedure	No	Yes	
	Investigations concerning charging scheme	No	Yes	
	Investigations concerning level or structure of user fees	No	Yes	
	Monitoring competition	No	Yes	

Driver	Sub-driver	1	10	Other answers
Powers of the Regulatory Authority				
	Can/Must start investigations upon request	Neither nor	Must	**5** (Can)
	Can/Must start investigations ex officio	Neither nor	Must	**5** (Can)
	Legally binding character of Regulatory Authority decisions	No	Yes and without suspensive effects	**3** (Yes and with suspensive effect)
	Determination by the regulatory body	Responsibility for decisions and rail expertise are not under one roof	Responsibility for decisions and rail expertise are under one roof	
	Possibility of imposing coercive means	No	Yes, high	**3** (Yes, but no or few figures given); **5** (Yes, middle)

Driver	Sub-driver	1	10	Other answers
	Possibility of imposing fines	No	Yes, high	**3** (Yes, but no or few figures given); **5** (Yes, middle)
	Possibility of issuing ex-post and/or ex-ante decisions	Neither nor	Ex-ante possible	**4** (Only ex-post)
	Legal certainty of ex-ante decisions	No	Yes	**3** (No empirical values available)
	Monitoring processes	No	Both	**6** (Only the results); **8** (Processes only)
Licensing				
	Independence of decision maker from incumbent	Dependent	Formally and de facto independent	**3** (Formally independent)
	Transparency of licensing process	No	Yes, with documentation / positive experience	**3** (Negative experience); **5** (No documentation / no experience)

Driver	Sub-driver	1	10	Other answers
Safety certificate				
	Independence of decision maker from incumbent	No	Formally and de facto independent	**3** (Formally independent)
	Transparency of issue process	No	Yes, with documentation / positive experience	**3** (Negative experience); **5** (No documentation / no experience)
Homologation of Vehicles				
	Independence of decision maker from incumbent	No	Formally and de facto independent	**3** (Formally independent)
	Transparency of the issuing process	No	Yes, with documentation / positive experience	**3** (Partially) **5** (No documentation)

Driver	Sub-driver	1	10	Other answers
Train Path Access Conditions				
	Existence of priority regulations for certain RUs	Yes	No	
	Non-discriminatory access to services[65]	No	Yes	**2** (Yes, but no experience); **5** ("Perceived discrimination" (Not shown in the Regulatory Body or serial process))
	Non-discriminatory marketing for all train paths[66]	No	Yes, unsolicited	**6** (Yes, only on request)
		No	Yes, no restrictions	**5** (Yes, with restrictions)

[65] This sub-driver combines the responses related to both freight and passenger transport in terms of the following: "Application for the allocation of train paths", "Right to use allocated train paths", "Use of points, switches and junctions", "Train control" and "Other information" (IBM Deutschland GmbH and Kirchner, 2011, Annex IV – Weightings and range of answers, pp.8-9).

[66] Marketing for all train paths is measured by two sub-drivers in the 2011 report: higher cells refer to "Recording and communication of available train paths" (combining responses related to both freight and passenger transport) and lower cells refer to "Providing

Driver	Sub-driver	1	10	Other answers
	Transparent mechanism to resolve conflicts[67]	No	Yes, documentation	
	Framework contracts	No	Yes	
	Transparent and standard train path allocation processes[68]	No, no documentation or not uniformly	Yes, documentation and uniformly	
Infrastructure Charging System				
	Coverage of infrastructure charging system[69]	No	Yes	

relevant supply-line information" (IBM Deutschland GmbH and Kirchner, 2011, Annex IV – Weightings and range of answers, p.10)

[67] This sub-driver combines the responses related to both freight and passenger transport (IBM Deutschland GmbH and Kirchner, 2011, Annex IV – Weightings and range of answers, p.9).

[68] This sub-driver combines the responses related to both freight and passenger transport (IBM Deutschland GmbH and Kirchner, 2011, Annex IV – Weightings and range of answers, p.9).

[69] This sub-driver comprises the responses to the following: "Application for the allocation of train paths", "Right to use allocated train paths", "Use of points, switches and junctions", "Train control", "Provision of further information", "Use of power supply equipment

Driver	Sub-driver	1	10	Other answers
	Publication of infrastructure charging system[70]	No	Yes	
	Uniform charging system[71]	No	Yes	

for traction current" and "Compensation for other services to track price" (IBM Deutschland GmbH and Kirchner, 2011, Annex IV – Weightings and range of answers, p.10).

[70] This sub-driver combines the responses related to both freight and passenger transport (IBM Deutschland GmbH and Kirchner, 2011, Annex IV – Weightings and range of answers, p.10).

[71] This sub-driver combines the responses related to both freight and passenger transport (IBM Deutschland GmbH and Kirchner, 2011, Annex IV – Weightings and range of answers, p.10).

Appendix E
Regulation index scores

This appendix will present in a tabular form the regulation index scores for the 17 European countries in the sample (here listed alphabetically). These scores have been extrapolated by the IBM and Kirchner studies (2002, 2004, 2007 and 2011) and subsequently manipulated. As described in Chapter 6, each of the 17 countries in the sample is assessed in respect to specific subject macro-areas which, in turn, correspond to the sum of drivers and sub-drivers. The scale of the scores for each sub-driver ranges from 1 (minimum) to 10 (maximum).

It is worth recalling that the reports were not published in a yearly basis. Therefore, the scores for the gap years is estimated by using an averaging approach, calculating the mean between the values connected to two consecutive reports. The absence of a sub-driver for a particular year is countered by using constant scores, which refer to that sub-driver's value found in the temporally closest report. Lastly, weights have all been aligned to those presented in the most recent report (IBM Deutschland GmbH and Kirchner, 2011), for which it is assumed that the authors have reached the best level of accuracy.

Table E.1 Regulation index scores for Austria (2002-2011)

AUSTRIA									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	10.00	8.50	7.00	8.50	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	10.00	5.50	1.00	5.50	10.00	10.00	10.00
	Transparency in case of proceedings/sanctions	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Independence of political influence	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Existence of an annual report	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	5.00	3.00	1.00	5.50	10.00	10.00	10.00
	Investigations concerning allocation procedure	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Investigations concerning charging scheme	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Investigations concerning level or structure of user fees	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Monitoring competition	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00

AUSTRIA									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	10.00	10.00	10.00	7.50	5.00	5.00	5.00
	Legally binding character of Regulatory Authority decisions	0.029	10.00	10.00	10.00	6.50	3.00	6.50	10.00
	Determination by the regulatory body	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Possibility of imposing coercive means	0.015	10.00	10.00	10.00	5.50	1.00	1.00	1.00
	Possibility of imposing fines	0.015	4.00	2.50	1.00	1.00	1.00	1.00	1.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Legal certainty of ex-ante decisions	0.015	3.00	3.00	3.00	3.00	3.00	6.50	10.00
	Monitoring processes	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Licensing									
	Independence of decision maker from incumbent	0.034	10.00	6.50	3.00	6.50	10.00	10.00	10.00
	Transparency of licensing process	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	3.00	2.00	1.00	5.50	10.00	10.00	10.00
	Transparency of issue process	0.012	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	3.00	2.00	1.00	5.50	10.00	10.00	10.00
	Transparency of the issuing process	0.059	1.00	1.00	1.00	5.50	10.00	10.00	10.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	1.00	5.50	10.00	10.00	10.00	10.00	10.00

AUSTRIA									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory access to services	0.055	1.00	5.50	10.00	8.00	6.00	8.00	10.00
	Non-discriminatory marketing for all train paths	0.041	1.00	4.25	7.50	7.75	8.00	8.00	8.00
	Transparent mechanism to resolve conflicts	0.028	10.00	5.50	1.00	5.50	10.00	10.00	10.00
	Framework contracts	0.028	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	1.00	1.00	1.00	5.50	10.00	10.00	10.00
Infrastructure Charging System									
	Coverage of infrastructure charging system	0.110	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Publication of infrastructure charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Uniform charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
TOTAL		1.000	6.51	6.79	7.06	7.96	8.85	9.05	9.25

Table E.2 Regulation index scores for Belgium (2002-2011)

BELGIUM									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	1.00	3.00	5.00	7.50	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Transparency in case of proceedings/sanctions	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Independence of political influence	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Existence of an annual report	0.017	1.00	1.00	1.00	1.00	1.00	5.50	10.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	1.00	5.50	10.00	9.50	9.00	9.50	10.00
	Investigations concerning allocation procedure	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Investigations concerning charging scheme	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Investigations concerning level or structure of user fees	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Monitoring competition	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	1.00	5.50	10.00	10.00	10.00	10.00	10.00

BELGIUM									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	1.00	5.50	10.00	7.50	5.00	5.00	5.00
	Legally binding character of Regulatory Authority decisions	0.029	1.00	5.50	10.00	10.00	10.00	6.50	3.00
	Determination by the regulatory body	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Possibility of imposing coercive means	0.015	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Possibility of imposing fines	0.015	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Legal certainty of ex-ante decisions	0.015	3.00	3.00	3.00	3.00	3.00	6.50	10.00
	Monitoring processes	0.015	5.00	6.50	8.00	8.00	8.00	4.50	1.00
Licensing									
	Independence of decision maker from incumbent	0.034	3.00	3.00	3.00	6.50	10.00	10.00	10.00
	Transparency of licensing process	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	3.00	6.50	10.00	10.00	10.00	6.50	3.00
	Transparency of issue process	0.012	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	1.00	2.00	3.00	3.00	3.00	6.50	10.00
	Transparency of the issuing process	0.059	10.00	5.50	1.00	2.00	3.00	6.50	10.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	1.00	1.00	1.00	3.00	5.00	7.50	10.00
	Non-discriminatory access to services	0.055	10.00	10.00	10.00	8.00	6.00	6.00	6.00

BELGIUM									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	1.00	3.25	5.50	6.13	6.75	8.38	10.00
	Transparent mechanism to resolve conflicts	0.028	1.00	3.00	5.00	7.50	10.00	10.00	10.00
	Framework contracts	0.028	10.00	5.50	1.00	5.50	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	10.00	10.00	10.00	7.00	4.00	7.00	10.00
Infrastructure Charging System									
	Coverage of infrastructure charging system	0.110	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Publication of infrastructure charging system	0.055	5.00	7.50	10.00	10.00	10.00	10.00	10.00
	Uniform charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
TOTAL		1.000	5.34	6.30	7.25	7.73	8.21	8.75	9.28

Table E.3 Regulation index scores for Denmark (2002-2011)

DENMARK									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	1.00	4.00	7.00	8.50	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	10.00	10.00	10.00	7.50	5.00	7.50	10.00
	Transparency in case of proceedings/sanctions	0.017	10.00	10.00	10.00	5.50	1.00	5.50	10.00
	Independence of political influence	0.017	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Existence of an annual report	0.017	1.00	1.00	1.00	1.00	1.00	5.50	10.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Investigations concerning allocation procedure	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Investigations concerning charging scheme	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Investigations concerning level or structure of user fees	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Monitoring competition	0.022	10.00	5.50	1.00	1.00	1.00	5.50	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	10.00	5.50	1.00	3.00	5.00	5.00	5.00

DENMARK									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	10.00	5.50	1.00	1.00	1.00	5.50	10.00
	Legally binding character of Regulatory Authority decisions	0.029	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Determination by the regulatory body	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Possibility of imposing coercive means	0.015	10.00	10.00	10.00	5.50	1.00	2.00	3.00
	Possibility of imposing fines	0.015	1.00	5.50	10.00	5.50	1.00	1.00	1.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Legal certainty of ex-ante decisions	0.015	3.00	3.00	3.00	3.00	3.00	3.00	3.00
	Monitoring processes	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Licensing									
	Independence of decision maker from incumbent	0.034	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of licensing process	0.017	10.00	10.00	10.00	6.50	3.00	6.50	10.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of issue process	0.012	1.00	5.50	10.00	7.50	5.00	7.50	10.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of the issuing process	0.059	7.00	8.50	10.00	7.50	5.00	7.50	10.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Non-discriminatory access to services	0.055	10.00	10.00	10.00	9.75	9.50	9.75	10.00

DENMARK									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparent mechanism to resolve conflicts	0.028	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Framework contracts	0.028	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Infrastructure Charging System									
	Coverage of infrastructure charging system	0.110	10.00	6.20	2.40	6.20	10.00	10.00	10.00
	Publication of infrastructure charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Uniform charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
TOTAL		1.000	8.58	8.42	8.25	8.22	8.19	8.89	9.59

Table E.4 Regulation index scores for Finland (2002-2011)

FINLAND									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	1.00	3.00	5.00	7.50	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	1.00	5.50	10.00	10.00	10.00	7.50	5.00
	Transparency in case of proceedings/sanctions	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Independence of political influence	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Existence of an annual report	0.017	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	1.00	5.50	10.00	5.50	1.00	5.50	10.00
	Investigations concerning allocation procedure	0.022	1.00	5.50	10.00	5.50	1.00	5.50	10.00
	Investigations concerning charging scheme	0.022	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Investigations concerning level or structure of user fees	0.022	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Monitoring competition	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	1.00	5.50	10.00	10.00	10.00	10.00	10.00

FINLAND									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	1.00	3.00	5.00	5.00	5.00	5.00	5.00
	Legally binding character of Regulatory Authority decisions	0.029	1.00	5.50	10.00	6.50	3.00	3.00	3.00
	Determination by the regulatory body	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Possibility of imposing coercive means	0.015	1.00	5.50	10.00	5.50	1.00	5.50	10.00
	Possibility of imposing fines	0.015	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Legal certainty of ex-ante decisions	0.015	3.00	3.00	3.00	3.00	3.00	3.00	3.00
	Monitoring processes	0.015	1.00	3.50	6.00	6.00	6.00	8.00	10.00
Licensing									
	Independence of decision maker from incumbent	0.034	3.00	6.50	10.00	10.00	10.00	10.00	10.00
	Transparency of licensing process	0.017	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	3.00	6.50	10.00	10.00	10.00	10.00	10.00
	Transparency of issue process	0.012	1.00	1.00	1.00	1.00	1.00	5.50	10.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	3.00	6.50	10.00	10.00	10.00	10.00	10.00
	Transparency of the issuing process	0.059	7.00	6.00	5.00	5.00	5.00	7.50	10.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	3.00	2.00	1.00	5.50	10.00	10.00	10.00
	Non-discriminatory access to services	0.055	7.00	8.50	10.00	6.00	2.00	1.75	1.50

FINLAND									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	10.00	9.00	8.00	8.00	8.00	9.00	10.00
	Transparent mechanism to resolve conflicts	0.028	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Framework contracts	0.028	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	7.00	8.50	10.00	10.00	10.00	10.00	10.00
Infrastructure Charging System									
	Coverage of infrastructure charging system	0.110	10.00	9.35	8.70	8.00	7.30	8.00	8.70
	Publication of infrastructure charging system	0.055	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Uniform charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
TOTAL		1.000	4.85	6.24	7.63	7.36	7.08	7.81	8.53

Table E.5 Regulation index scores for France (2002-2011)

FRANCE									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	1.00	3.00	5.00	7.50	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Transparency in case of proceedings/sanctions	0.017	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Independence of political influence	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Existence of an annual report	0.017	10.00	10.00	10.00	10.00	10.00	5.50	1.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	1.00	3.00	5.00	7.50	10.00	10.00	10.00
	Investigations concerning allocation procedure	0.022	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Investigations concerning charging scheme	0.022	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Investigations concerning level or structure of user fees	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Monitoring competition	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	1.00	5.50	10.00	7.50	5.00	7.50	10.00

FRANCE									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	1.00	1.00	1.00	3.00	5.00	5.00	5.00
	Legally binding character of Regulatory Authority decisions	0.029	1.00	1.00	1.00	1.00	1.00	2.00	3.00
	Determination by the regulatory body	0.015	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Possibility of imposing coercive means	0.015	1.00	1.00	1.00	1.00	1.00	2.00	3.00
	Possibility of imposing fines	0.015	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Legal certainty of ex-ante decisions	0.015	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Monitoring processes	0.015	1.00	3.50	6.00	6.00	6.00	6.00	6.00
Licensing									
	Independence of decision maker from incumbent	0.034	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of licensing process	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	10.00	10.00	10.00	6.50	3.00	6.50	10.00
	Transparency of issue process	0.012	1.00	1.00	1.00	1.00	1.00	5.50	10.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	3.00	2.00	1.00	2.00	3.00	3.00	3.00
	Transparency of the issuing process	0.059	10.00	5.50	1.00	2.00	3.00	6.50	10.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	10.00	5.50	1.00	3.00	5.00	3.00	1.00
	Non-discriminatory access to services	0.055	7.00	6.00	5.00	3.85	2.70	3.55	4.40

FRANCE									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	1.00	3.25	5.50	5.50	5.50	5.50	5.50
	Transparent mechanism to resolve conflicts	0.028	1.00	3.00	5.00	5.00	5.00	7.50	10.00
	Framework contracts	0.028	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	1.00	1.00	1.00	2.50	4.00	4.79	5.58
Infrastructure Charging System									
	Coverage of infrastructure charging system	0.110	10.00	7.10	4.20	7.10	10.00	10.00	10.00
	Publication of infrastructure charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Uniform charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
TOTAL		1.000	5.33	5.04	4.74	5.68	6.61	7.16	7.70

Table E.6 Regulation index scores for Germany (2002-2011)

GERMANY									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency in case of proceedings/sanctions	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Independence of political influence	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Existence of an annual report	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Investigations concerning allocation procedure	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Investigations concerning charging scheme	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Investigations concerning level or structure of user fees	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Monitoring competition	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00

GERMANY									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	10.00	10.00	10.00	7.50	5.00	5.00	5.00
	Legally binding character of Regulatory Authority decisions	0.029	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Determination by the regulatory body	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Possibility of imposing coercive means	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Possibility of imposing fines	0.015	1.00	5.50	10.00	5.50	1.00	1.00	1.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Legal certainty of ex-ante decisions	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Monitoring processes	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Licensing									
	Independence of decision maker from incumbent	0.034	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of licensing process	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	10.00	5.50	1.00	5.50	10.00	10.00	10.00
	Transparency of issue process	0.012	10.00	5.50	1.00	5.50	10.00	10.00	10.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of the issuing process	0.059	6.00	5.50	5.00	7.50	10.00	10.00	10.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	8.00	6.50	5.00	7.50	10.00	10.00	10.00
	Non-discriminatory access to services	0.055	10.00	10.00	10.00	9.75	9.50	9.75	10.00

GERMANY									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	7.00	5.25	3.50	4.50	5.50	5.50	5.50
	Transparent mechanism to resolve conflicts	0.028	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Framework contracts	0.028	10.00	5.50	1.00	5.50	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	10.00	7.50	5.00	6.00	7.00	8.50	10.00
Infrastructure Charging System									
	Coverage of infrastructure charging system	0.110	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Publication of infrastructure charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Uniform charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
TOTAL		1.000	9.40	8.95	8.50	8.98	9.46	9.54	9.61

Table E.7 Regulation index scores for Greece (2002-2011)

GREECE									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Transparency in case of proceedings/sanctions	0.017	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Independence of political influence	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Existence of an annual report	0.017	1.00	1.00	1.00	1.00	1.00	5.50	10.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	1.00	1.00	1.00	2.00	3.00	2.50	2.00
	Investigations concerning allocation procedure	0.022	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Investigations concerning charging scheme	0.022	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Investigations concerning level or structure of user fees	0.022	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Monitoring competition	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	1.00	1.00	1.00	5.50	10.00	10.00	10.00

GREECE									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	1.00	1.00	1.00	3.00	5.00	5.00	5.00
	Legally binding character of Regulatory Authority decisions	0.029	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Determination by the regulatory body	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Possibility of imposing coercive means	0.015	1.00	1.00	1.00	1.00	1.00	2.00	3.00
	Possibility of imposing fines	0.015	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	1.00	1.00	1.00	1.00	1.00	3.00	5.00
	Legal certainty of ex-ante decisions	0.015	3.00	3.00	3.00	3.00	3.00	2.00	1.00
	Monitoring processes	0.015	1.00	1.00	1.00	1.00	1.00	5.50	10.00
Licensing									
	Independence of decision maker from incumbent	0.034	10.00	5.50	1.00	5.50	10.00	10.00	10.00
	Transparency of licensing process	0.017	1.00	1.00	1.00	1.00	1.00	5.50	10.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Transparency of issue process	0.012	1.00	1.00	1.00	1.00	1.00	5.50	10.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	10.00	5.50	1.00	1.00	1.00	5.50	10.00
	Transparency of the issuing process	0.059	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Non-discriminatory access to services	0.055	1.00	1.00	1.00	1.50	2.00	1.95	1.90

GREECE									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	1.00	1.00	1.00	4.50	8.00	8.00	8.00
	Transparent mechanism to resolve conflicts	0.028	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Framework contracts	0.028	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	1.00	1.00	1.00	3.25	5.50	7.75	10.00
Infrastructure Charging System						0.00	0.00		
	Coverage of infrastructure charging system	0.110	10.00	5.50	1.00	4.85	8.70	8.70	8.70
	Publication of infrastructure charging system	0.055	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Uniform charging system	0.055	1.00	1.00	1.00	1.00	1.00	1.00	1.00
TOTAL		1.000	3.14	2.33	1.51	3.79	6.07	6.91	7.74

Table E.8 Regulation index scores for Ireland (2002-2011)

IRELAND									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Transparency of competence of Regulatory Authority	0.017	10.00	5.50	1.00	1.00	1.00	1.00	1.00
	Transparency in case of proceedings/sanctions	0.017	10.00	10.00	10.00	5.50	1.00	1.00	1.00
	Independence of political influence	0.017	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Existence of an annual report	0.017	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Investigations concerning allocation procedure	0.022	10.00	10.00	10.00	5.50	1.00	1.00	1.00
	Investigations concerning charging scheme	0.022	10.00	10.00	10.00	5.50	1.00	1.00	1.00
	Investigations concerning level or structure of user fees	0.022	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Monitoring competition	0.022	1.00	1.00	1.00	1.00	1.00	5.50	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	1.00	1.00	1.00	1.00	1.00	1.00	1.00

IRELAND									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Legally binding character of Regulatory Authority decisions	0.029	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Determination by the regulatory body	0.015	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Possibility of imposing coercive means	0.015	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Possibility of imposing fines	0.015	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Legal certainty of ex-ante decisions	0.015	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Monitoring processes	0.015	10.00	5.50	1.00	1.00	1.00	1.00	1.00
Licensing									
	Independence of decision maker from incumbent	0.034	10.00	5.50	1.00	1.00	1.00	1.00	1.00
	Transparency of licensing process	0.017	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Safety certificate						0.00	0.00		
	Independence of decision maker from incumbent	0.012	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of issue process	0.012	10.00	5.50	1.00	5.50	10.00	10.00	10.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Transparency of the issuing process	0.059	1.00	1.00	1.00	5.50	10.00	10.00	10.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Non-discriminatory access to services	0.055	1.00	1.00	1.00	1.00	1.00	1.50	2.00

IRELAND									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Transparent mechanism to resolve conflicts	0.028	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Framework contracts	0.028	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Transparent and standard train path allocation processes	0.039	1.00	1.00	1.00	1.00	1.00	5.50	10.00
Infrastructure Charging System									
	Coverage of infrastructure charging system	0.110	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Publication of infrastructure charging system	0.055	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Uniform charging system	0.055	1.00	1.00	1.00	1.00	1.00	5.50	10.00
TOTAL		1.000	2.36	2.01	1.66	1.97	2.28	3.77	5.26

Table E.9 Regulation index scores for Italy (2002-2011)

ITALY									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	5.00	7.50	10.00	10.00	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	5.00	5.00	5.00	7.50	10.00	10.00	10.00
	Transparency in case of proceedings/sanctions	0.017	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	Independence of political influence	0.017	10.00	10.00	10.00	10.00	10.00	5.50	1.00
	Existence of an annual report	0.017	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	5.00	4.50	4.00	7.00	10.00	10.00	10.00
	Investigations concerning allocation procedure	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Investigations concerning charging scheme	0.022	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Investigations concerning level or structure of user fees	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Monitoring competition	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	5.00	7.50	10.00	10.00	10.00	10.00	10.00

ITALY									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	1.00	3.00	5.00	5.00	5.00	5.00	5.00
	Legally binding character of Regulatory Authority decisions	0.029	1.00	5.50	10.00	6.50	3.00	6.50	10.00
	Determination by the regulatory body	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Possibility of imposing coercive means	0.015	1.00	5.50	10.00	5.50	1.00	5.50	10.00
	Possibility of imposing fines	0.015	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Legal certainty of ex-ante decisions	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Monitoring processes	0.015	5.00	7.50	10.00	10.00	10.00	10.00	10.00
Licensing									
	Independence of decision maker from incumbent	0.034	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of licensing process	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	1.00	1.00	1.00	2.00	3.00	6.50	10.00
	Transparency of issue process	0.012	1.00	1.00	1.00	5.50	10.00	10.00	10.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	1.00	1.00	1.00	2.00	3.00	6.50	10.00
	Transparency of the issuing process	0.059	7.00	6.00	5.00	4.00	3.00	3.00	3.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	1.00	5.50	10.00	10.00	10.00	5.50	1.00
	Non-discriminatory access to services	0.055	10.00	10.00	10.00	8.00	6.00	8.00	10.00

ITALY									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	10.00	9.00	8.00	7.75	7.50	7.75	8.00
	Transparent mechanism to resolve conflicts	0.028	5.00	7.50	10.00	10.00	10.00	10.00	10.00
	Framework contracts	0.028	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Infrastructure Charging System									
	Coverage of infrastructure charging system	0.110	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Publication of infrastructure charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Uniform charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
TOTAL		1.000	6.33	7.17	8.02	8.01	7.99	8.27	8.55

Table E.10 Regulation index scores for Luxembourg (2002-2011)

LUXEMBOURG									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	1.00	3.00	5.00	7.50	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Transparency in case of proceedings/sanctions	0.017	10.00	10.00	10.00	5.50	1.00	5.50	10.00
	Independence of political influence	0.017	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Existence of an annual report	0.017	1.00	1.00	1.00	1.00	1.00	5.50	10.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Investigations concerning allocation procedure	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Investigations concerning charging scheme	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Investigations concerning level or structure of user fees	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Monitoring competition	0.022	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	1.00	5.50	10.00	5.50	1.00	5.50	10.00

LUXEMBOURG									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	1.00	3.00	5.00	3.00	1.00	3.00	5.00
	Legally binding character of Regulatory Authority decisions	0.029	1.00	5.50	10.00	5.50	1.00	2.00	3.00
	Determination by the regulatory body	0.015	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Possibility of imposing coercive means	0.015	1.00	5.50	10.00	5.50	1.00	2.00	3.00
	Possibility of imposing fines	0.015	1.00	1.00	1.00	1.00	1.00	2.00	3.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	1.00	1.00	1.00	1.00	1.00	2.50	4.00
	Legal certainty of ex-ante decisions	0.015	1.00	1.00	1.00	1.00	1.00	2.00	3.00
	Monitoring processes	0.015	1.00	1.00	1.00	1.00	1.00	5.50	10.00
Licensing									
	Independence of decision maker from incumbent	0.034	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Transparency of licensing process	0.017	5.00	5.00	5.00	7.50	10.00	10.00	10.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Transparency of issue process	0.012	1.00	5.50	10.00	10.00	10.00	10.00	10.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	3.00	6.50	10.00	10.00	10.00	10.00	10.00
	Transparency of the issuing process	0.059	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Non-discriminatory access to services	0.055	1.00	3.00	5.00	3.50	2.00	5.10	8.20

LUXEMBOURG									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	1.00	4.50	8.00	4.50	1.00	2.25	3.50
	Transparent mechanism to resolve conflicts	0.028	1.00	3.00	5.00	5.00	5.00	7.50	10.00
	Framework contracts	0.028	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	1.00	5.50	10.00	7.00	4.00	7.00	10.00
Infrastructure Charging System									
	Coverage of infrastructure charging system	0.110	1.00	5.50	10.00	7.75	5.50	7.75	10.00
	Publication of infrastructure charging system	0.055	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Uniform charging system	0.055	1.00	5.50	10.00	10.00	10.00	10.00	10.00
TOTAL		1.000	1.86	4.86	7.85	7.10	6.35	7.55	8.76

Table E.11 Regulation index scores for Netherlands (2002-2011)

NETHERLANDS									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	5.00	5.00	5.00	7.50	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Transparency in case of proceedings/sanctions	0.017	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Independence of political influence	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Existence of an annual report	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	1.00	1.00	1.00	4.50	8.00	9.00	10.00
	Investigations concerning allocation procedure	0.022	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Investigations concerning charging scheme	0.022	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Investigations concerning level or structure of user fees	0.022	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Monitoring competition	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	5.00	3.00	1.00	5.50	10.00	10.00	10.00

NETHERLANDS									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	5.00	3.00	1.00	3.00	5.00	5.00	5.00
	Legally binding character of Regulatory Authority decisions	0.029	1.00	1.00	1.00	2.00	3.00	3.00	3.00
	Determination by the regulatory body	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Possibility of imposing coercive means	0.015	1.00	1.00	1.00	2.00	3.00	6.50	10.00
	Possibility of imposing fines	0.015	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Legal certainty of ex-ante decisions	0.015	3.00	3.00	3.00	3.00	3.00	6.50	10.00
	Monitoring processes	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Licensing									
	Independence of decision maker from incumbent	0.034	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of licensing process	0.017	5.00	5.00	5.00	5.00	5.00	7.50	10.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	10.00	8.50	7.00	8.50	10.00	10.00	10.00
	Transparency of issue process	0.012	10.00	5.50	1.00	1.00	1.00	1.00	1.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of the issuing process	0.059	10.00	10.00	10.00	6.50	3.00	3.00	3.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Non-discriminatory access to services	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00

NETHERLANDS									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparent mechanism to resolve conflicts	0.028	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Framework contracts	0.028	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Infrastructure Charging System									
	Coverage of infrastructure charging system	0.110	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Publication of infrastructure charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Uniform charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
TOTAL		1.000	7.46	7.58	7.69	8.28	8.86	9.03	9.20

Table E.12 Regulation index scores for Norway (2002-2011)

NORWAY									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Transparency in case of proceedings/sanctions	0.017	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Independence of political influence	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Existence of an annual report	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	1.00	1.00	1.00	1.00	1.00	5.50	10.00
	Investigations concerning allocation procedure	0.022	10.00	5.50	1.00	5.50	10.00	10.00	10.00
	Investigations concerning charging scheme	0.022	10.00	5.50	1.00	5.50	10.00	10.00	10.00
	Investigations concerning level or structure of user fees	0.022	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Monitoring competition	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	5.00	3.00	1.00	3.00	5.00	7.50	10.00

NORWAY									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	5.00	3.00	1.00	3.00	5.00	5.00	5.00
	Legally binding character of Regulatory Authority decisions	0.029	10.00	5.50	1.00	2.00	3.00	3.00	3.00
	Determination by the regulatory body	0.015	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Possibility of imposing coercive means	0.015	10.00	5.50	1.00	2.00	3.00	6.50	10.00
	Possibility of imposing fines	0.015	1.00	1.00	1.00	2.00	3.00	6.50	10.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Legal certainty of ex-ante decisions	0.015	3.00	3.00	3.00	3.00	3.00	2.00	1.00
	Monitoring processes	0.015	1.00	3.50	6.00	6.00	6.00	3.50	1.00
Licensing									
	Independence of decision maker from incumbent	0.034	3.00	6.50	10.00	10.00	10.00	10.00	10.00
	Transparency of licensing process	0.017	1.00	1.00	1.00	3.00	5.00	5.00	5.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of issue process	0.012	1.00	1.00	1.00	5.50	10.00	10.00	10.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of the issuing process	0.059	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Non-discriminatory access to services	0.055	1.00	5.50	10.00	8.00	6.00	8.00	10.00

NORWAY									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	1.00	4.50	8.00	5.75	3.50	5.75	8.00
	Transparent mechanism to resolve conflicts	0.028	5.00	7.50	10.00	10.00	10.00	10.00	10.00
	Framework contracts	0.028	5.00	3.00	1.00	5.50	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	1.00	5.50	10.00	10.00	10.00	10.00	10.00
Infrastructure Charging System			0.00	0.00	0.00				
	Coverage of infrastructure charging system	0.110	10.00	9.35	8.70	9.35	10.00	10.00	10.00
	Publication of infrastructure charging system	0.055	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Uniform charging system	0.055	1.00	5.50	10.00	10.00	10.00	10.00	10.00
TOTAL		1.000	4.29	5.10	5.90	6.87	7.84	8.23	8.63

Table E.13 Regulation index scores for Portugal (2002-2011)

PORTUGAL									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	10.00	9.00	8.00	9.00	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Transparency in case of proceedings/sanctions	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Independence of political influence	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Existence of an annual report	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	3.00	6.50	10.00	10.00	10.00	10.00	10.00
	Investigations concerning allocation procedure	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Investigations concerning charging scheme	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Investigations concerning level or structure of user fees	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Monitoring competition	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	5.00	7.50	10.00	10.00	10.00	10.00	10.00

PORTUGAL									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	Legally binding character of Regulatory Authority decisions	0.029	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Determination by the regulatory body	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Possibility of imposing coercive means	0.015	10.00	10.00	10.00	6.50	3.00	3.00	3.00
	Possibility of imposing fines	0.015	10.00	10.00	10.00	10.00	10.00	7.50	5.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Legal certainty of ex-ante decisions	0.015	3.00	3.00	3.00	3.00	3.00	6.50	10.00
	Monitoring processes	0.015	1.00	5.50	10.00	10.00	10.00	10.00	10.00
Licensing									
	Independence of decision maker from incumbent	0.034	3.00	6.50	10.00	10.00	10.00	10.00	10.00
	Transparency of licensing process	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of issue process	0.012	1.00	5.50	10.00	7.50	5.00	7.50	10.00
Homologation of Vehicles						0.00	0.00		
	Independence of decision maker from incumbent	0.059	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of the issuing process	0.059	10.00	5.50	1.00	5.50	10.00	10.00	10.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Non-discriminatory access to services	0.055	7.00	8.50	10.00	8.00	6.00	8.00	10.00

PORTUGAL									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	1.00	4.50	8.00	5.75	3.50	5.75	8.00
	Transparent mechanism to resolve conflicts	0.028	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Framework contracts	0.028	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	7.00	8.50	10.00	10.00	10.00	10.00	10.00
Infrastructure Charging System									
	Coverage of infrastructure charging system	0.110	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Publication of infrastructure charging system	0.055	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Uniform charging system	0.055	1.00	5.50	10.00	10.00	10.00	10.00	10.00
TOTAL		1.000	5.58	7.38	9.18	9.17	9.17	9.42	9.67

Table E.14 Regulation index scores for Spain (2002-2011)

SPAIN									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Transparency in case of proceedings/sanctions	0.017	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Independence of political influence	0.017	10.00	10.00	10.00	10.00	10.00	5.50	1.00
	Existence of an annual report	0.017	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	1.00	1.00	1.00	4.00	7.00	8.50	10.00
	Investigations concerning allocation procedure	0.022	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Investigations concerning charging scheme	0.022	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Investigations concerning level or structure of user fees	0.022	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Monitoring competition	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	1.00	1.00	1.00	5.50	10.00	10.00	10.00

SPAIN									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	1.00	1.00	1.00	3.00	5.00	5.00	5.00
	Legally binding character of Regulatory Authority decisions	0.029	1.00	1.00	1.00	2.00	3.00	3.00	3.00
	Determination by the regulatory body	0.015	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Possibility of imposing coercive means	0.015	1.00	1.00	1.00	5.50	10.00	6.50	3.00
	Possibility of imposing fines	0.015	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Legal certainty of ex-ante decisions	0.015	3.00	3.00	3.00	3.00	3.00	3.00	3.00
	Monitoring processes	0.015	1.00	5.50	10.00	10.00	10.00	10.00	10.00
Licensing									
	Independence of decision maker from incumbent	0.034	10.00	5.50	1.00	2.00	3.00	3.00	3.00
	Transparency of licensing process	0.017	1.00	1.00	1.00	5.50	10.00	10.00	10.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	1.00	1.00	1.00	2.00	3.00	3.00	3.00
	Transparency of issue process	0.012	1.00	1.00	1.00	1.00	1.00	5.50	10.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	1.00	1.00	1.00	2.00	3.00	3.00	3.00
	Transparency of the issuing process	0.059	1.00	1.00	1.00	2.00	3.00	6.50	10.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Non-discriminatory access to services	0.055	1.00	1.00	1.00	3.50	6.00	5.75	5.50

SPAIN									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	1.00	1.00	1.00	4.50	8.00	8.00	8.00
	Transparent mechanism to resolve conflicts	0.028	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Framework contracts	0.028	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	1.00	1.00	1.00	5.50	10.00	10.00	10.00
Infrastructure Charging System									
	Coverage of infrastructure charging system	0.110	1.00	1.00	1.00	1.70	2.40	2.40	2.40
	Publication of infrastructure charging system	0.055	1.00	1.00	1.00	5.50	10.00	10.00	10.00
	Uniform charging system	0.055	1.00	1.00	1.00	5.50	10.00	10.00	10.00
TOTAL		1.000	1.62	1.70	1.77	4.32	6.87	7.02	7.18

Table E.15 Regulation index scores for Sweden (2002-2011)

SWEDEN									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	1.00	4.00	7.00	8.50	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency in case of proceedings/sanctions	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Independence of political influence	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Existence of an annual report	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Investigations concerning allocation procedure	0.022	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Investigations concerning charging scheme	0.022	10.00	5.50	1.00	5.50	10.00	10.00	10.00
	Investigations concerning level or structure of user fees	0.022	10.00	5.50	1.00	5.50	10.00	10.00	10.00
	Monitoring competition	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	10.00	7.50	5.00	5.00	5.00	5.00	5.00

SWEDEN									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	10.00	7.50	5.00	5.00	5.00	5.00	5.00
	Legally binding character of Regulatory Authority decisions	0.029	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Determination by the regulatory body	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Possibility of imposing coercive means	0.015	1.00	5.50	10.00	6.50	3.00	3.00	3.00
	Possibility of imposing fines	0.015	1.00	1.00	1.00	5.50	10.00	6.50	3.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Legal certainty of ex-ante decisions	0.015	10.00	10.00	10.00	10.00	10.00	6.50	3.00
	Monitoring processes	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Licensing									
	Independence of decision maker from incumbent	0.034	3.00	6.50	10.00	10.00	10.00	10.00	10.00
	Transparency of licensing process	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	3.00	6.50	10.00	10.00	10.00	10.00	10.00
	Transparency of issue process	0.012	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	3.00	6.50	10.00	10.00	10.00	10.00	10.00
	Transparency of the issuing process	0.059	1.00	5.50	10.00	7.50	5.00	7.50	10.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Non-discriminatory access to services	0.055	7.00	8.50	10.00	10.00	10.00	10.00	10.00

SWEDEN									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	9.00	7.25	5.50	6.75	8.00	9.00	10.00
	Transparent mechanism to resolve conflicts	0.028	1.00	5.50	10.00	10.00	10.00	10.00	10.00
	Framework contracts	0.028	10.00	5.50	1.00	5.50	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	6.00	8.00	10.00	7.75	5.50	7.75	10.00
Infrastructure Charging System									
	Coverage of infrastructure charging system	0.110	10.00	6.20	2.40	6.20	10.00	10.00	10.00
	Publication of infrastructure charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Uniform charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
TOTAL		1.000	6.82	7.41	8.00	8.60	9.20	9.37	9.54

Table E.16 Regulation index scores for Switzerland (2002-2011)

SWITZERLAND									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	1.00	4.00	7.00	8.50	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	10.00	7.50	5.00	7.50	10.00	10.00	10.00
	Transparency in case of proceedings/sanctions	0.017	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	Independence of political influence	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Existence of an annual report	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	9.00	9.50	10.00	9.00	8.00	8.00	8.00
	Investigations concerning allocation procedure	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Investigations concerning charging scheme	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Investigations concerning level or structure of user fees	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Monitoring competition	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00

SWITZERLAND									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	1.00	1.00	1.00	3.00	5.00	5.00	5.00
	Legally binding character of Regulatory Authority decisions	0.029	10.00	10.00	10.00	6.50	3.00	3.00	3.00
	Determination by the regulatory body	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Possibility of imposing coercive means	0.015	1.00	5.50	10.00	5.50	1.00	1.00	1.00
	Possibility of imposing fines	0.015	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Legal certainty of ex-ante decisions	0.015	3.00	3.00	3.00	3.00	3.00	3.00	3.00
	Monitoring processes	0.015	10.00	8.00	6.00	6.00	6.00	6.00	6.00
Licensing									
	Independence of decision maker from incumbent	0.034	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of licensing process	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of issue process	0.012	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of the issuing process	0.059	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	9.00	9.50	10.00	10.00	10.00	10.00	10.00
	Non-discriminatory access to services	0.055	10.00	9.70	9.40	9.70	10.00	10.00	10.00

SWITZERLAND									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	10.00	9.00	8.00	8.25	8.50	8.75	9.00
	Transparent mechanism to resolve conflicts	0.028	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Framework contracts	0.028	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Infrastructure Charging System									
	Coverage of infrastructure charging system	0.110	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Publication of infrastructure charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Uniform charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
TOTAL		1.000	9.19	9.22	9.24	9.17	9.10	9.12	9.13

Table E.17 Regulation index scores for United Kingdom (2002-2011)

UNITED KINGDOM									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
General Aspects of the Regulatory Authority									
	Existence of Regulatory Authority pursuant to Art.30 Directive 2001/14/EC (responsible for non-discriminatory access)	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of competence of Regulatory Authority	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency in case of proceedings/sanctions	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Independence of political influence	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Existence of an annual report	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Object of the Regulation									
	Inspection of network statement (10 aspects)	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Investigations concerning allocation procedure	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Investigations concerning charging scheme	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Investigations concerning level or structure of user fees	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Monitoring competition	0.022	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Powers of the Regulatory Authority									
	Can/Must start investigations upon request	0.015	10.00	7.50	5.00	5.00	5.00	5.00	5.00

UNITED KINGDOM									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Can/Must start investigations ex officio	0.015	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	Legally binding character of Regulatory Authority decisions	0.029	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Determination by the regulatory body	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Possibility of imposing coercive means	0.015	10.00	10.00	10.00	6.50	3.00	3.00	3.00
	Possibility of imposing fines	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Possibility of issuing ex-post and/or ex-ante decisions	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Legal certainty of ex-ante decisions	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Monitoring processes	0.015	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Licensing									
	Independence of decision maker from incumbent	0.034	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of licensing process	0.017	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Safety certificate									
	Independence of decision maker from incumbent	0.012	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of issue process	0.012	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Homologation of Vehicles									
	Independence of decision maker from incumbent	0.059	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparency of the issuing process	0.059	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Train Path Access Conditions									
	Existence of priority regulations for certain RUs	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Non-discriminatory access to services	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00

UNITED KINGDOM									
Driver	**Sub-driver**	**Weight**	**2002**	**2003**	**2004**	**2005-2006**	**2007**	**2008-2010**	**2011**
	Non-discriminatory marketing for all train paths	0.041	10.00	10.00	10.00	9.50	9.00	9.50	10.00
	Transparent mechanism to resolve conflicts	0.028	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Framework contracts	0.028	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Transparent and standard train path allocation processes	0.039	7.00	8.50	10.00	10.00	10.00	10.00	10.00
Infrastructure Charging System									
	Coverage of infrastructure charging system	0.110	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Publication of infrastructure charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Uniform charging system	0.055	10.00	10.00	10.00	10.00	10.00	10.00	10.00
TOTAL		1.000	9.81	9.83	9.85	9.78	9.71	9.73	9.75